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RESEARCH CENTER JUL 2 5 1977

Burbank Day at Santa Rosa

The seventh of March, Mr. Burbank's birthday, has been set aside by the legislature of California as Burbank Day. On this day the school children plant trees and have other appropriate exercises, and local groups of them always come to felicitate Mr. Burbank on his birthday. The picture shows the group that gathered on Mr. Burbank's sixty-fifth birthday, March seventh, 1914.

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LUTHER BURBANK, 1849-1926

HIS METHODS AND DISCOVERIES AND THEIR PRACTICAL APPLICATION

PREPARED FROM
HIS ORIGINAL FIELD NOTES
COVERING MORE THAN 100,000 EXPERIMENTS
MADE DURING FORTY YEARS DEVOTED
TO PLANT IMPROVEMENT

WITH THE ASSISTANCE OF

The Luther Burbank Society

AND ITS
ENTIRE MEMBERSHIP

UNDER THE EDITORIAL DIRECTION OF

John Whitson and Robert John

AND

Henry Smith Williams, M. D., LL. D.

VOLUME XII

ILLUSTRATED WITH
105 DIRECT COLOR PHOTOGRAPH PRINTS PRODUCED BY A
NEW PROCESS DEVISED AND PERFECTED FOR
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NEW YORK AND LONDON
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Volume XII—By Chapters

Foreword.....Page 3

I Luther Burbank—His Boyhood on a Massachusetts Farm
—The Conception of an Idea and the Birth of a Great Ambition..... 7

II Luther Burbank—The Early Years in Santa Rosa
—The Period of Bitter Struggle..... 61

III Luther Burbank—His Patience Rewarded
—The Period of Great Achievement..... 107

IV Luther Burbank—The Sum of His Work With Plant Life
—What It Has Meant to Science and Agriculture..... 155

V Luther Burbank—The Bearing of His Work on Human Life
—On Improving the Human Plant..... 203

VI The Luther Burbank Society
—What It Has Done and What It Proposes..... 247

List of Direct Color Photograph Prints in Volume XII..... 289

Subject Index to Volumes I-XII..... 293

47835

Foreword to Volume XII

Having covered the entire range of plants with which Mr. Burbank has worked, and having obtained a thorough understanding of all the methods he has employed, we are given, in this volume, a summing up of what has gone before, with an eye not only to its application to plant life, but to the immediate improvement of the human plant.

In this volume also will be found the intimate life story of Luther Burbank; from his boyhood days in Massachusetts, through his first hardships in Santa Rosa, to the final glory of success, together with a report of the work of the Luther Burbank Society and an outline of its plans for the widespread dissemination of Mr. Burbank's methods and discoveries in the future.

THE EDITORS.

Mr. Burbank's Mother

To Olive Ross Burbank, his mother, Mr. Burbank bears striking resemblance not alone in his physical features but in many of his mental traits. Mr. Burbank's mother spent the closing years of her life with him at Santa Rosa, and she was at all times a source of inspiration to him.

Luther Burbank—His Boyhood on a Massachusetts Farm

The Conception of an Idea And the Birth of a Great Ambition

HAD my father been a superstitious man my advent would perhaps have been unwelcome, for I was my father's thirteenth child. I have no reason to suppose, however, that this fact was ever given a thought. It is indeed very likely that at the time of my coming no one counted heads carefully enough to find out that the newcomer had drawn the traditionally unlucky number.

In point of fact, it was only by reference to the Family Bible that anyone was likely to know the full roll of the fraternity, for several of my father's children had died in infancy, and some of the oldest ones had gone out into the world before the date of my arrival.

I speak of "my *father's* children" because my mother was his third wife, and she had borne only two children before my birth, both of whom

had died in infancy. So there was a considerable gap between me and the next older child, and as I ranked eldest in the new coterie, which comprised presently two other children—my sister Emily and my brother Alfred respectively—I occupied in a sense the position of an elder brother in the fraternity, my half brothers and sisters being so much senior to me as to seem almost like members of an older generation.

In my work of later years I was to attain my successes very largely through practice in plant breeding of the method of "quantity production," as the reader of these volumes is aware. I have sometimes said facetiously that I gained a clew to this method by contemplation of my own relation to the fraternity into which I was born.

Our household, like so many other New England households of the period, furnished an illustration of quantity production in the breeding of the human race. And I have more than once reflected with amusement that if my father had been content with a family of twelve offspring—which in these later days would be considered a not insignificant brood—there would have been no horticulturist bearing his name, and it would perhaps never have been known that the factors of a devoted plant developer were in the Burbank heredity.

Luther Burbank's Birthplace

This is the old Burbank homestead at Lancaster, Mass. It is easy to see how a boy brought up amidst such surroundings might imbibe a love of nature,—granted, of course, right heredity. Luther Burbank's love of nature was his earliest, as it is his most abiding, passion.

In so far, then, as my work may have been useful to the human race, the principle of quantity production has been justified.

Viewing the matter in less facetious mood, I should perhaps hasten to add that the inherent love of nature which was the stimulus to my life work was inherited, in all probability, from my mother. I was her third child, only, as already noted, and of course the fact that my father had children by earlier wives had no bearing on the hereditary influences that she contributed, which, as just suggested, were probably largely responsible for the impelling bent that has always dominated me. So, in the last analysis, it is necessary to recall that, in so far as we may draw analogies between plant heredities and human heredities, the production of a horticultural Burbank illustrated a principle lying back of and taking precedence over quantity production—the principle, namely, of the selection of the right racial strains for blending.

It is useless to produce plants in quantity unless the parent plants are endowed with the right potentialities.

And doubtless my father never would have had a child who was an ardent nature worshiper had he not married for his third wife a woman who was a nature lover.

It must not be forgotten, to be sure, that my father had a cousin, Professor Levi Sumner Burbank, who was a man of strong scientific proclivities, and who, indeed, was in part responsible for stimulating my love of nature, inasumch as he lived with us at times, and I often rambled with him in the woods and gained from him a knowledge of the names of rocks and flowers and trees.

This Burbank cousin was a friend of Agassiz. He was an early member of the American Association for the Advancement of Science. He wrote books on technical aspects of geology, one of these, it is recalled, being entitled "The Eozonal Limestones of Eastern Massachusetts. He often took long trips with Agassiz to places of scientific interest. He was for some time curator of geology of the Boston Society of Natural History, and he had a large and well selected geological collection. Through him I gained a certain knowledge of geology, and in particular of the work of Agassiz, although I met the great scientist himself on one occasion only.

The Hereditary Background

I mention this scientific Burbank cousin as suggesting that there were certain proclivities that might in part account for the instincts of a plant developer in the strains of Burbank heredity. But, as what has just been said will further suggest,

Where Luther Burbank Was Schooled

This simple and unpretentious building, nestling in the woods, was the seat of the Lancaster Academy, where Mr. Burbank received the instruction that constituted the foundation of his book education. But what the boy learned in the fields and woodlands surrounding the academy was far more important than anything gleaned from books within the walls of the building itself.

these were seemingly of a somewhat formal and technically scientific order, whereas the inspiration for my work has been found rather in an ardent love of nature.

I desired to deal with the forces of life and mold the plastic forms of living organisms rather than to classify the fixed and immutable phenomena of dead ones, which would appear to be the province of the geologist.

Doubtless, however, the strain of interest in matters scientific that was evidenced in the geological proclivities of my Burbank cousin constituted an important hereditary element that, mingled with the more poetical and sympathetic elements of nature-worship which were in the hereditary strains of my mother's family, rounded out the characteristics of an essentially practical plant developer who loved his task for the very doing of it, yet who never forgot that practical ends must be achieved.

My father, Samuel Walton Burbank, was a man of sterling integrity, scholarly tastes, strong convictions, and unusually good business abilities. He was very indulgent, and fond of his children, and gave to each the best education within his power. He was much respected by his neighbors, and greatly enjoyed associating with them. He was a sincere man, noted in the neighborhood as one

Santa Clara Count
Jose.

who could always be depended upon; not for a display of his views in words but for his sterling example.

There were men in the community who advocated one course and followed another; my father was known always as a man who was true to his principles. What he preached he would practice; his acts were always in accord with the tenets of his belief.

I have always chosen to believe that these homely and traditional New England virtues, bred in the bone, were not likely to have been omitted from the heritage of my father's children.

My mother, whose maiden name was Olive Ross, was an active and intelligent woman, who looked after her multiform household duties with scrupulous care. Being naturally expert in reading human character, she was of great assistance to my father in his business, as he employed much help, and dealt with men of all classes and of various nationalities.

My mother was fond of flowers, and despite her exacting duties, she had the place surrounded by them. I have always felt that my passionate love of flowers, which is said to have been manifested in infancy, was inherited from her.

Despite the poetical element in her temperament, my mother was eminently practical. She

Luther Burbank at the Age of Nine

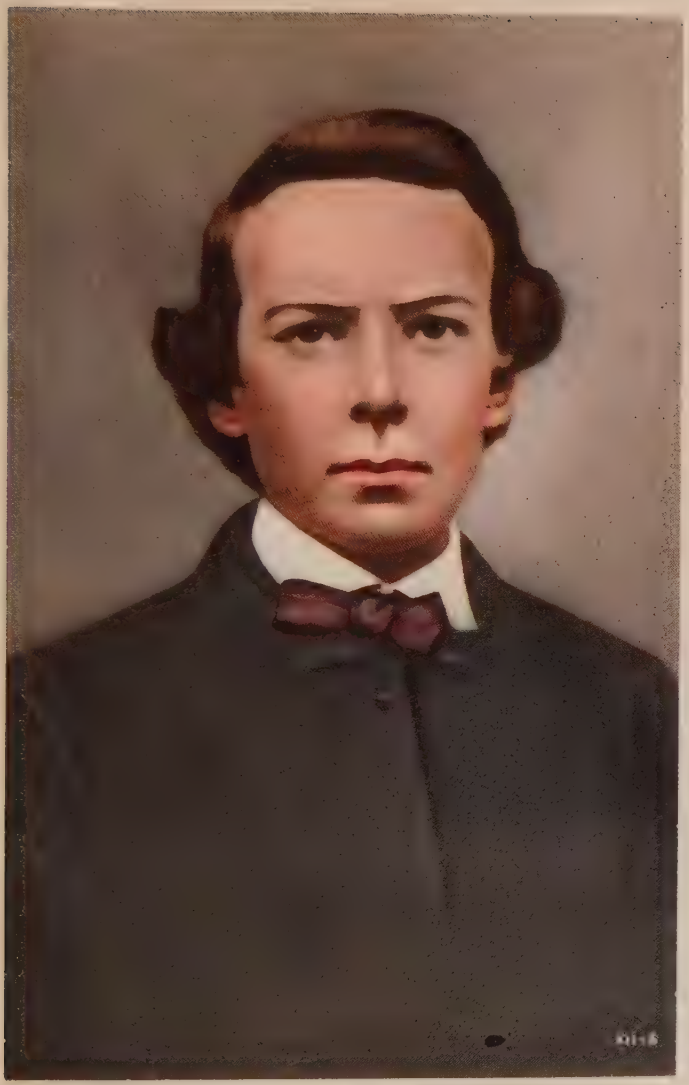
No one who has personal acquaintance with the mature Luther Burbank can glance at this picture without recalling the phrase: "The child is father to the man." As to mere physical appearance the man quite commonly bears small resemblance to his boyhood self: but Mr. Burbank is a striking exception to this. This is a "speaking likeness" of the mature Luther Burbank, particularly as regards the expression about the mouth.

seemed always to know where anything that was wanted could be found, and better still, she was usually able to find it. She was in the truest sense a helpmate to her husband in all respects. Being of mature years when she married, she bore only five children, and she outlived my father by many years, reaching the age of ninety-six years, and passing her declining days in my home at Santa Rosa, active to the very last and keenly alive to all that was going on around her.

As to aspects of remoter heredity, I have never very greatly concerned myself. It is said, however, that one branch of the family on my father's side was probably Belgian-Dutch far back in the fifteenth century, this stock supplying the first authentic trace of our ancestral line.

We next hear of the Burbanks in the North of England, from which place five Burbank brothers emigrated to America.

We find by Custom House records that Joseph Burbank came in the ship Abigail from London in 1635, and that John Burbank, from whom our family descended, was made a voter at Rowley, Massachusetts, in 1640. My father's mother was Ruth Felch, originally from Wales. My mother's family, the Rosses, came from Scotland. Her mother's name was Burpee, and her family was said to be of French descent.



Luther Burbank at the Age of Fourteen

A very mature young man was Luther Burbank at the age of fourteen. It requires no very keen knowledge of physiognomy to detect in this portrait the characteristics of personality that have made Mr. Burbank's life one of notable accomplishment.

Thus it will be seen that my ancestry, like that of most people in America, includes strains of several nationalities. In talking with people who seem to me over-zealous about their ancestors, I am sometimes moved to say that although I never discovered that any royal or exceptionally aristocratic blood flows in our veins, yet, on the other hand, there appears to be no record that any ancestor was ever detected as a criminal—which, perhaps, from the standpoint of the student of heredity, is a matter of far greater importance than the other.

The Burbanks, so far as I personally know of them, were generally farmers, paper manufacturers, railroad men, teachers, and clergymen; while on the Ross side my ancestors were more often merchants, mechanics, and horticulturists.

Few families of New England, I suppose, have a better-sustained record of representation in the learned professions, in civic duties, in military stations, and in public reforms, than the Burbanks.

The Physical and Mental Environment of Childhood

My father's farm was located about three miles north of the little village of Lancaster, Massachusetts, just off the main road to Harvard.

There I was born—at least so the great family Bible and the family traditions assure me—March

Luther Burbank at the Age of Seventeen

When this picture was taken, Luther Burbank had already begun his work of plant development, to the extent of making numberless experiments in grafting, in the selecting of seeds from plants showing special qualities, and even in cross-pollenation. He had not as yet produced any striking results, to be sure, but he was acquiring the technique that was to stand him in such good stead in later years.

7th of the year 1849. And there my childhood and boyhood days were passed.

The town of Lancaster is one of the most picturesque spots in all New England. Its scenery is of the English type. There are rows of queenly elms of wonderful size arching its highways and gracefully ornamenting its meadows. The typical New England hills and valleys; a river—the Nashua—placidly flowing, and small wood-encircled lakes to give variety to the landscape; sloping hills and picturesque vistas, with the usual complement of woods and shrubs and flowers—these things, treasured in memory, make up a picture of rare charm and beauty.

As to the town of Lancaster itself, it is one of those old New England villages that has a personality. The life in such a town is as individual in its way as the traditional life in Athens, or the present-day life of Edinburgh or Tokyo or Concord.

The picture of the life in Lancaster in the middle of the nineteenth century is as distinctive as a portrait by Van Dyke or a statue by Phidias.

Whoever would understand the intellectual development of our time must comprehend in some measure the unique and distinctive character of such communities as Lancaster, the influence of which is not to be measured by any numerical

Luther Burbank at the Age of Twenty-five

This picture was taken not long after Mr. Burbank attained his first very notable success in plant development, through the production of the Burbank potato. He was at this time a highly accomplished gardener, thoroughly expert in all the details of plant management. The following year (1875) he was to migrate to California to take up his permanent abode at Santa Rosa.

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count of inhabitants any more than the potentialities of the seed of a plant are to be predicated from observation of its size.

Our home at Lancaster was charged with intellectual activity during the years of my youth, for it was a rendezvous for ministers, teachers, and lecturers. My father was interested in all of the subjects that were before the public at that time, and we children had great advantages from the associations that he established.

And that was indeed a notable era in the history of civilization. It was the time in which New England was being transformed by the migration of hosts of its best people to the new fields of the middle and far west. In the year of my birth, as it chanced, gold was discovered in California, and the excitement in the region of Boston I am told was greater than had probably been known since the occasion of the memorable "tea party."

Many of the more venturesome prepared to cross the plains, led by the golden lure. And those that remained were full of eager expectancy as they waited for news from the new Eldorado.

The reminiscences of this excitement were still in the air in my early boyhood. But before I came to adolescence there were other burning questions that took precedence even over the gold fever.

The long-smouldering antislavery fires were preparing to burst forth. And just at the time when the great civic conflict was becoming more and more obviously inevitable, an intellectual and religious turmoil of world wide scope was evoked by the pronouncements of Darwin and Wallace, which seemed to shake the fundamental notions as to man's creation, his past history, and his destiny.

These disturbing questions of national policy and intellectual and spiritual welfare were part and parcel of our everyday life in Lancaster during the years when I was passing from boyhood into adolescence.

As a child, I listened eagerly to the discussions long before I could more than half understand them, when on not rare occasions a visiting minister or lecturer was entertained at my father's table. Only the eager desire to hear these discussions overcame the awe of a strange face that led me always to dread the coming of a stranger even though I longed to hear his message.

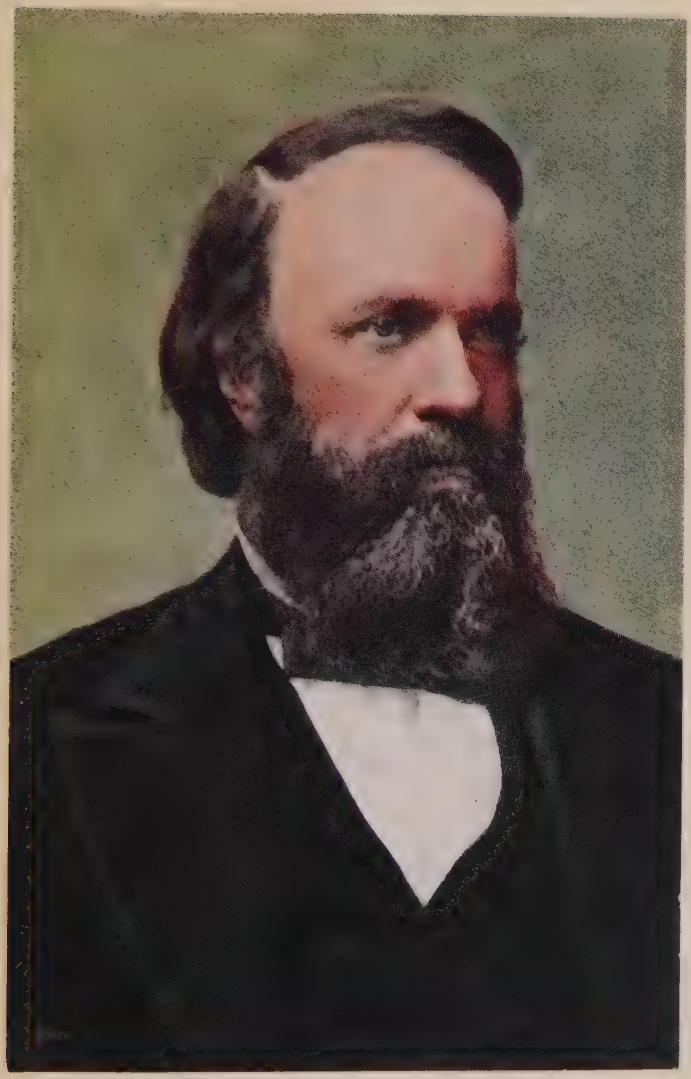
In my earliest boyhood, as my sister and mother in later years recalled with amusement, I was likely to shun the table when a place was laid for a strange guest, assuring my mother that I did not care for dinner, and running to the fields to escape being seen by the newcomer. Even a boy's appetite could not master bashfulness.

I myself well recall that even in somewhat later years I cringed before the kindly scrutiny of our visitors and was dumb before their questions, though drinking in their words with eager interest so long as they were not addressed to me in particular.

It was the same kind of childish timidity, which I take it is the common endowment of children whose mental development tends to outrun the physical, that made my first school-going an ordeal. I could not at first find voice to recite in the awesome presence of half a hundred schoolmates. And the semi-weekly recitation day, on which each pupil was supposed to come to the platform and declaim, was looked forward to by me with about the same degree of anguished solicitude, I verily believe, with which a condemned criminal contemplates his execution day.

Fortunately a sympathetic teacher presently permitted me to write an essay weekly in lieu of declaiming; and after that the school days were days of almost unalloyed pleasure.

Yet I shall always feel that I was sent to school far earlier than was good for me. This, of course, was no fault of my parents. They but followed the traditions of the times. Who could blame the New England housewife of that period, with duties that nowadays would be thought to require a



The Purchaser of the Burbank Potato

The Burbank potato, Mr. Burbank's first important commercial plant development, was purchased by J. J. Gregory, of Marblehead, Mass. Mr. Gregory named the variety the Burbank seedling. Mr. Burbank used the money thus acquired (it was only $150) to pay his expenses to California, where he felt that the work of plant developing could be carried out under more advantageous conditions.

coterie of servants, and with a child always at the breast and another scarcely out of the cradle, if she sent the entire brood of her progeny who were old enough to walk to the shelter of the schoolroom, where at least they were out of her way and out of physical danger for the larger part of the day?

Not, indeed, that the New England housewife herself would have stated the matter just in this way. She, in common with her husband, believed that her offspring were born with the traditions of the sin of our first ancestors weighing upon them, and that only the most rigid intellectual discipline combined with the most persistent spiritual teaching by precept and example could release them from that hereditary bondage.

That the doctrines of the Catechism and the rules of the three R's should be ground into the brain of the child while it was still at its most plastic stage, was accepted as unchallengeable.

The belief that the schoolhouse on every hilltop and the church in every valley constitute the landmarks of civilization was an ingrained fundamental of the New England tradition.

And so youngsters who should have been in the fields gathering flowers and revelling in the sunshine, drinking in the music of the birds and gaining strength and health for the tasks of mature life

were instead crowded into schoolrooms that in winter were overheated and ill-ventilated, and forced to the unwelcome and unnatural and harmful task of scanning pages of pothooks and cramming their unwilling brains with formulae, to their permanent detriment.

Not even on Saturday was there a respite; except that each second week school was dismissed at noon on that day in order that opportunity might be given in the afternoon for the washing of the children's clothes. Even a thrifty housewife who had a dozen or fifteen boys and girls of graded sizes and ages to look after could not be expected to provide more than a single suit of underwear for each member of her brood.

So it was jestingly said, and the jest was not altogether without its savor of reality, that it was often necessary to put the children in barrels while their clothes were in the wash-tub.

But in any event, the necessity for maintaining a certain measure of cleanliness had the effect of permitting the children to have a half holiday once in two weeks.

And I opine that most of them were more benefited by that half holiday, even though it were spent in a barrel or its equivalent, than they would have been by following their school tasks during the same period.

A Simple but Important Equipment

These simple garden tools are perhaps more often in Mr. Burbank's hands than any others. The trowel is the universal transplanting implement; the other tools are soil-looseners and weed-exterminators. A small garden plot could be kept in order with these tools alone.

The week that was so largely devoted to school going was rounded out on the Sabbath by a strenuous course in church going. There was one service in the forenoon, Sunday school at noon, and another service in the afternoon.

It was not considered seemly that little children should wander in the woods or engage in any frolicsome pastime in the interval of church going. But our parents were peculiarly indulgent and they sometimes permitted us to walk quietly into the garden or orchard to look at the corn or apple-blossoms, always with the proviso that we must be very quiet.

The Religious Environment

It is a little difficult for the present generation to gain a clear conception of the New England Sabbath of the time of my boyhood; but this outline at least will give a general impression of its lugubriousness, and it may readily be inferred that the day thus given over to dolorous tasks was not one to which the child would look forward joyously.

Nor, for the most part, do those who were children in that generation look back upon the Sabbath day experiences with satisfaction.

At least they served the purpose, however, of supplying a church-going experience adequate for a lifetime.

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Little did the good people who so sedulously led their flocks to church and subjected them to the bombardment of repeated sermons, suspect that they were cultivating an attitude of mind that would insure that the churches of succeeding decades should be nearly vacant. Indeed, they would have been horrified had they been told such a thing; yet I think we need not doubt that on the whole such was the influence of their well meant efforts.

It adds to our understanding of the curiously archaic relation of the church to the community, even in that comparatively recent period, to reflect that it was obligatory in Lancaster a short time before for each family to contribute to the support of the Unitarian Church.

My father was not a Unitarian—regarding that sect rather as heretical—yet he supplied sundry loads of bricks without charge for the building of a new Unitarian Church.

In subsequent years the law that made the Church practically a part of the civic organism had been repealed, and thenceforward people were allowed to follow their own inclinations in the matter of church contributions. But this severance of church and state, so to speak, did not so much represent a reaction against the doctrines of a particular church, as a general reaction

A Crude but Effective Implement

This is an exceedingly useful implement for leveling the soil preparatory to planting seeds, and for packing the soil about the roots of transplanted seedlings and cuttings. It is a tool that you can make with the aid of a rake handle and a couple of boards, and it should be part of the equipment of even the smallest garden.

against the obligatory recognition of any church whatever.

For there had come about in the course of one or two decades a most iconoclastic change in the attitude of mind of the leaders of thought throughout Christendom towards the tenets that had hitherto been thought essential to man's spiritual welfare.

Following the publication of Darwin's *Origin of Species* in 1859, the intellectual world was in a ferment, and nowhere was the influence of the new ideas more quickly felt or tumultuously argued than in New England.

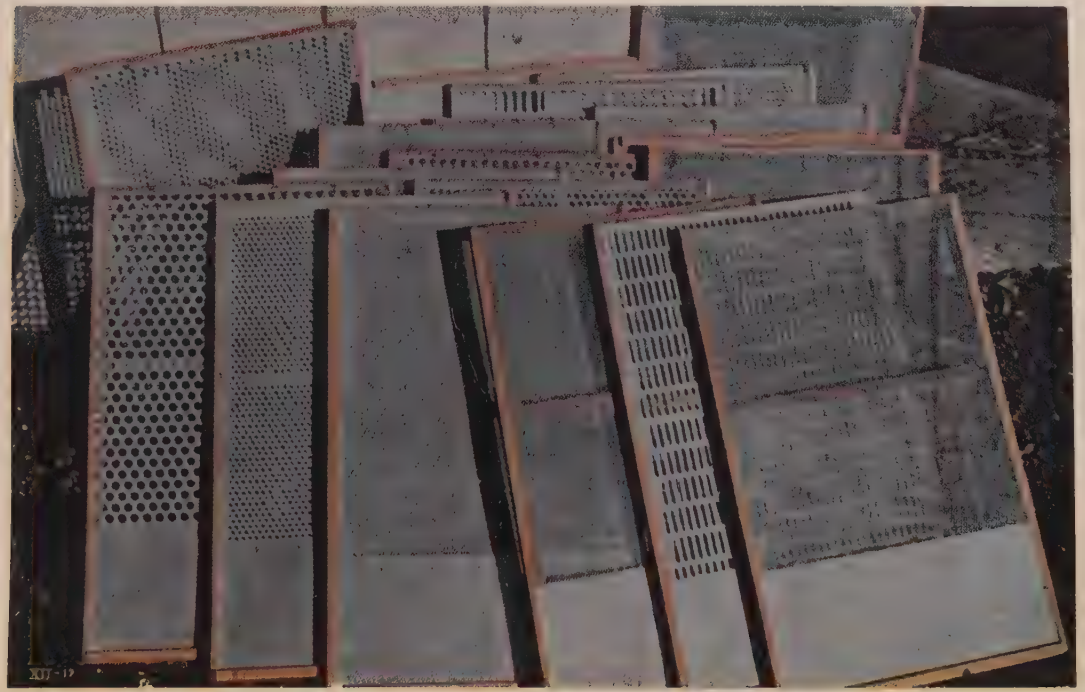
I was ten years old when Darwin's iconoclastic document was promulgated, and hence I grew into adolescence in the very period when it was most ardently bruited. The idea that animals and plants have not originated through special creation but have evolved one form from another throughout long ages; and the logical culmination of that idea in the inclusion of man himself in the evolutionary chain—these are commonplaces to-day. They are familiar doctrines that might find expression from every orthodox pulpit.

But in those stormy days of the sixties, such ideas were not merely heretical—they seemed absolutely revolutionary.

If this new view were accepted, in the minds

An Assortment of Sieves

In preparing soils, Mr. Burbank sometimes wishes to use very finely pulverized sand or loam, and sometimes a pebbly soil of much coarser consistency. An assortment of screens enables him to get just the kind of soil he wants.



of a large proportion of those who expounded the subject in the early days in New England, nothing good would remain.

Of course the history of the spread of this new doctrine duplicated the history of every other new idea. For the most part, people of the elder generation could no more change their old views and accept new ones than they could make over their stature or the color of their eyes.

But, on the other hand, we of the younger generation were quick to see the logicality of the new conception, and were not hampered in its acceptance by any cherished beliefs of a contradictory kind.

Not, indeed, that we children for the most part concerned ourselves greatly about the matter. We went through our regular task of Bible reading and church-going and learned our Sunday school lessons, just as we performed other tasks that we could not escape. But none the less were there instilled into the very substructure of our minds the essentials of the new manner of thinking, the new attitude toward the world in which we live and all its organic creatures.

And when in later years we went out into the world and came to choose our own paths and to adopt mental and religious garbs of our own choosing, the subconscious influence of the new

A Collection of Sieves

These sieves are, of course, merely fine screens conveniently framed, so that they can be used to fill boxes or plots of various sizes. The small ones are particularly suitable for use in the greenhouse and with the small "flats" in which most of Mr. Burbank's seeds are planted.

teaching everywhere made itself felt, determining a receptive attitude of mind that presaged the new intellectual era.

If ever there was a time when it was true that "the old order changeth" in the profoundest application of the words to the most sacred beliefs of men, that time was the closing epoch of the nineteenth century.

Play and Work

It is worth while to dwell on these less tangible aspects of the environment of boyhood, because their influence was probably more important than that of many events that have to do with the regular routine of the workaday world.

As to that routine, not much need be said, because there was little associated with it that was individual or characteristic or that was largely influential in determining the activities of my later years.

The recreations of such scant leisure hours as the New England child of this period could find were the usual recreations of childhood. I was rather too frail of body to enter with full enthusiasm into the rougher sports. But in general the sports and amusements of the New England child were of rather a subdued order, as became the intellectual atmosphere in which we lived.

Coasting and skating were among our most

Soil-Stirring Implements

Here are various types of plows and harrows, some of them to be drawn by horses, others pushed by hand. They are indispensable adjuncts of gardening on a comprehensive scale.

boisterous pastimes, and the more usual recreations included such functions as spelling-bees and husking-bees.

I recall with a good deal of pleasure that on one occasion I personally built a dam across a large trout stream on our farm and flooding a neighboring meadow so that we could have a large skating pond. I was about nine or ten years of age at the time, if memory serves me, and the damming of the stream was permitted on the plea that it would increase the crop of cranberries. But of course what I chiefly had in mind was the making of a place for skating, that being a sport of which I was especially fond.

I well remember my hard work through the October and November days — though where the time was found in the intervals of schooling cannot be surmised—in building the dam which later flooded not only my father's cranberry meadows but a great number of acres adjoining.

One of the happiest days of my life was Christmas of that year, when the great glassy sheet of ice was alive with my schoolmates and companions, darting here and there singing and shouting, enjoying to the utmost a New England skating party.

Incidentally, it may be recalled that the same meadows, at another season, furnished the inter-

Marking Rows for Planting

Mr. Burbank's gardens have always shown evidences of his mathematical precision. Nothing is ever planted or set out "hit or miss" in his garden. Anything that is worth doing at all is worth doing well, according to his practical philosophy. The picture gives a very useful hint as to the manipulation of a clothesline in marking out lines of any length.

esting experience of gathering cranberries with long handled rakes. The berries were raked from the bushes into sacks fastened on the rake handles. A single man could gather several bushels in an hour. My brother David has recalled in recent years the keen enjoyment I manifested in watching this operation when but a child.

But the chief occupations of our leisure hours were of a more prosaic character than sledding or skating. My father was an unusually prosperous farmer, but he was also a manufacturer. With so large a family, he found it necessary to supplement the resources of field and orchard.

It chanced that on the farm there was an extensive bank of fine clay, and as pottery was in great demand at that time my father engaged in its manufacture successfully for several years. But later there were mammoth manufacturing plants established in the vicinity, and these created so great a demand for building material that it was found profitable to transform the pottery into a brick yard.

As it required wood to burn brick, my father began buying woodlands, ultimately acquiring large holdings. His judgment of the value of growing woodlands was good, and his business prospered. He employed a large number of men each summer to make and burn the brick, some

Setting Out Small Seedlings

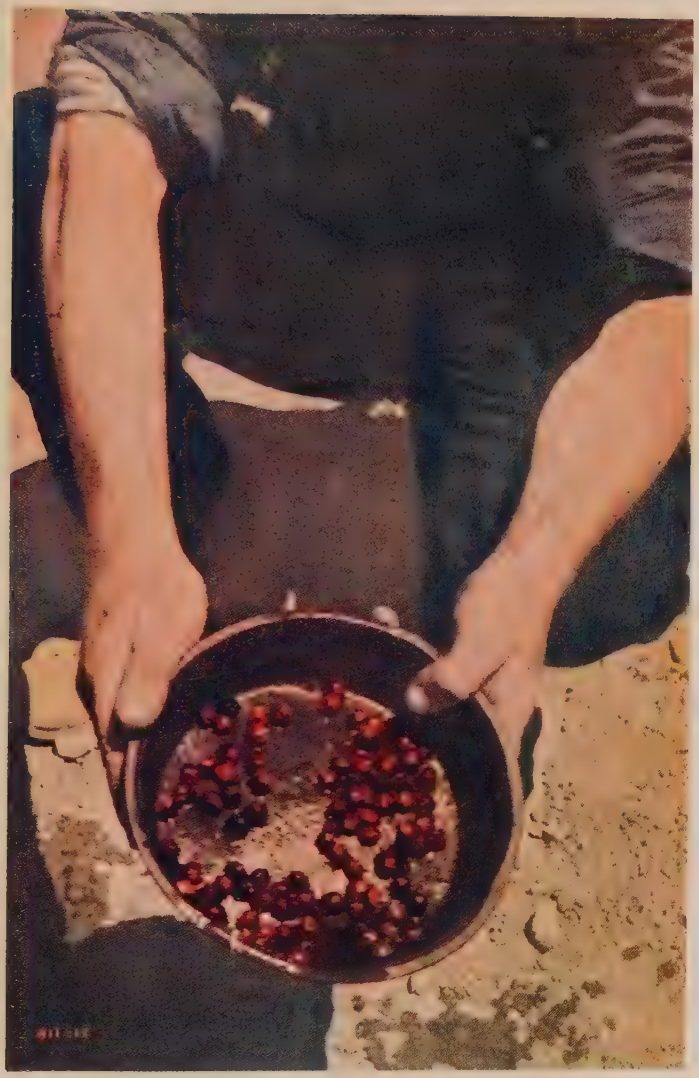
Here a furrow has been made with a flat spade along the clothesline shown in the preceding picture; and a trench is being dug with a curved spade, the excavation being just wide enough and deep enough to give ample room for the seedlings or plants with roots that are to be set out along this part of the line. For the setting out of cuttings, the narrow trench made by the spade is sufficient.

of whom were engaged during the winter in chopping wood and in hauling brick to the railroad stations or to the various towns within fifty miles of our farm.

And of course we boys were pressed into the service so soon as we were large enough, to lend a hand at various of the simpler phases of brick-making. It is recalled by my brother that I did not undertake the turning of brick, which is a work that is rather hard on delicate hands, with unusual enthusiasm. But, on the other hand, my brother Alfred and myself when quite young, perhaps only six or eight years of age, used to drive the oxen with loads of brick to Clinton, Lancaster Village, Harvard, and other nearby towns, and this part of the work I found thoroughly enjoyable.

My father also furnished much material from the farm woodlands for the powder and paper mills in town; and it was a great treat to me when taking material to the manufacturers of carpet, paper, cloth, and wire to see the wonderful processes employed in transforming the raw material into such intricate forms of utility and beauty.

When the time came for me to take up a definite occupation, I not unnaturally turned to one of the factories, the more willingly because of always having had the keenest interest in things mechanical. Indeed, the love of experimenting



Washing Seeds

That "trifles make perfection" is as true of gardening as of any other art. One of the trifles that is often neglected by the amateur—but never in Mr. Burbank's gardens—is the careful cleaning of the seeds, if necessary by washing, to minimize danger of injury from fungous growths or insects, and to guard against the inclusion of foreign seeds or impurities of any kind.

with the making of windmills, water wheels, statuary, and ornamental pottery had always been but slightly subordinate to the love of wandering in the woods and studying the flowers and trees and wild creatures.

It was recalled by my elders that from earliest boyhood I had taken delight in the investigation of a little wooden cradle in the attic; also that an old spinning wheel and sundry delapidated pieces of furniture had particularly allured me.

A little later I had experimented in the back yard with an old tea-kettle, and developed an untiring steam whistle that aroused but probably did not especially please the neighborhood.

In due course my mechanical experiments continued until a miniature steam engine was perfected which had such practicality that I afterwards sold it to be used in propelling a small pleasure boat. So I might claim to have been an innovater in the development of the now popular motor boat. My experiments, however, were made a few decades too early.

At the Lancaster Academy, which I attended after gaining sufficient preliminary knowledge in the district school, I was particularly interested in free hand drawing, which was found very easy, and I had always an interest in designing. So my father, observing these propensities, concluded

Covering Seeds with Sand

After seeds are planted in the flats or elsewhere, they are covered with a sprinkling of sand of just the right depth. A very common mistake of the amateur gardener is to cover the seeds too deeply. This gives the cotyledons needless work in crowding up to the light. Sometimes it prevents the germination of seeds that otherwise might have grown satisfactorily.

that his son be a mechanic. An uncle, Luther Ross, was superintendent of the wood working department of the great Ames Manufacturing Company which had plants at Worcester, Groten, and Chicopee, Mass. So a place was readily secured for me in the factory at Worcester.

When entering on my duties I was first employed in turning plow-rounds, for which I received the munificent sum of 50 cents a day.

I also paid 50 cents a day for board. And as there are seven days in the week when one must have food and shelter and only six working days, it is obvious that I was 50 cents in arrears at the close of each week.

As this arrangement did not appeal to my business instincts, I induced my uncle to grant me the privilege of working by the piece instead of by the day. By special activity under this arrangement I was able to make two or three times as much as formerly.

But I had not been long at the work before the knack at contriving things mechanical came to my aid. I conceived an improvement in the turning lathe that would enable me, I thought, to perform the work much more expeditiously. The invention proved a success, and with its aid I was enabled to earn as much as sixteen dollars a day—a very notable advance on my initial wage.

Seeds in the Greenhouse

A corner of Mr. Burbank's greenhouse in seed-gathering time. Seeds of many varieties are here collected for drying, preparatory to being stored for the winter or immediately planted, as the case may be. Note the sieves at hand, to be used if necessary in screening out impurities, or separating seeds of different sizes.

The company were pleased with the invention, and I might have remained indefinitely in their employ at a remunerative salary. But the clouds of dust that came from the oak lumber began to impair my health and it was thought best to leave the shop for a while at least. So my experience as a manufacturer of wood products ended. My subsequent work was to be performed in the open; except, indeed, for a brief period when I returned to the Ames works for temporary employment at turning and at pattern making.

Choosing a Profession

I was always frail of body and of delicate physique, although wiry of build and not without good powers of endurance. But shop life further weakened me, and I had the misfortune soon after leaving the shop to be partially overcome by the heat, owing to a three mile run on an exceedingly hot day to notify the local officers of the Boston and Maine Railroad that sparks from one of their locomotives had set my father's wood lots on fire, and to obtain aid in controlling the flames.

Perhaps it was this experience in particular that led me to think of taking up medicine as a profession. On the whole it seemed to me that this would be most congenial, and I studied for a year with the intention of becoming a doctor. I

Rare Seeds in Common Receptacles

Rare seeds and common ones receive the same careful attention in Mr. Burbank's greenhouse. Every seed has potentialities that give it the aspect of a Pandora box in the eyes of the imaginative plant developer. But simple kitchen utensils serve as useful a purpose in assorting the seeds as would be served by the most costly and elaborate receptacles. Even tin cans may be pressed into the service in Mr. Burbank's greenhouse, as the picture suggests.

have had occasion constantly to realize in later life how valuable this experience was. The knowledge of physiology and practical hygiene thus gained could many times be applied to the direction and interpretation of plant experiments.

It is quite possible that I should have continued my studies and have graduated in medicine had not the death of my father occurred at this time. This changed all our plans. The family moved to Groton—now Ayer—Massachusetts, where we lived for two years and where I took up the line of work that was to reveal an inherent bent and to lay the foundations of future activities.

That is to say, I became a practical nurseryman and gardener.

It was perhaps inevitable that I should have come ultimately to take up this line of work, because from earliest childhood my chief delight had been found in the study of nature and in particular in the companionship of flowers.

It is recorded by those who watched tenderly over me in my childhood that I was a quiet, serious child, whose most notable trait was a love, amounting almost to reverence, for flowers of every kind.

"A blossom placed in the baby hands," writes my sister, "would always stay his falling tears. Flowers were never destroyed by him, but if, per-

chance, one fell to pieces his effort was always to reconstruct it. Flowers were his first toys, and when he was old enough to toddle about they became his pets. Especially dear to his heart was a thornless cactus (*Epiphyllum*) which he carried about in his arms, until in an unhappy moment he stumbled and fell, breaking pot and plant. This was his first great sorrow, although by persistent effort and care the plant was made to flourish again."

Conceivably this early association with a thornless cactus may not have been without its subconscious influence in determining an interest in the development of new races of thornless cactus half a century later.

Be that as it may, the inherent fondness for plants that the incident illustrates was accentuated year by year. My earliest recollections center about the pleasure experienced in wandering in the woods, gathering wild flowers in summer and in winter making excursions among the walnuts, birches, oaks, and pines that, viewed in perspective, seem to have been almost of the proportions of Sequoias, but which visits of later years revealed as trees of very ordinary proportions.

Even while employed in the turning factory I spent every spare moment in wandering about the country, and the letters home were full of refer-

Seeds Drying In the Open

Here seeds of many kinds are spread out for drying in the sun in a snug corner near the door of Mr. Burbank's greenhouse. Note also the pile of prepared soil, ready for use in case it should be desired to test any of the seeds by immediate planting.

ences to the beauties of field and trees and flowers, the songs of birds, the piping of the frogs, and all the homely manifestations of animate nature that appeal to the eye and ear that are receptive to them.

So, as was said, it was perhaps inevitable that sooner or later an occupation should be taken up that would bring me hourly in contact with nature. But it was not until my twenty-first year that I entered specifically on the work, although of course I had been trained in all the tasks of the gardener and fruit grower on my father's farm from earliest childhood.

I had all along been serving an apprenticeship that stood me in good stead now that the work of market gardener and seed raiser was taken up as a business.

Yet it is not certain that I should have been led to put this knowledge to practical use at this time had it not been for the stimulation and fresh enthusiasm that came from the reading of an extraordinary book. This book was Darwin's *Animals and Plants Under Domestication.* The work was first published, it will be recalled, in 1868. It probably fell into my hands a year or so later. It came to me with a message that was not merely stimulating but compelling. It aroused my imagination, gave me insight into the world of

Gathering Apples at Sebastopol

A Burbank four-horse team, hauling apples at the Sebastopol farm. Mr. Burbank does not raise fruit for the market, all his trees being given over to experimental uses. But after the selected specimens have been gathered there remain quantities of fruit that can be put to less scientific uses. The size of the wagon here shown suggests the abundance of the apple crop.

plant life, and developed within me an insistent desire to go into the field and find the answer to the problems that the book only suggested.

In particular it showed to me the plants of the field in a new light.

I had understood from Darwin's earlier work that all life has evolved from lower forms; that, therefore, species are not fixed and immutable but are plastic, and amenable to the influences of their environment.

But I had not before understood to what an extent species of every kind all about us vary, and what possibilities of modification of existing forms are contingent on such variation. From that hour plant life presented to me a sort of challenge to test its capacities, to investigate its traits, to invent new ideals of growth and to endeavor to mould the plant in accordance with these ideals.

Thus, thanks to the inspiration of Darwin's work, my ideas were finally crystallized. The philosophical bent inherited from my father and the love of nature that I owed to my mother were to work now in harmony.

Guided by the practical instincts that were perhaps a joint heritage from both strains of my ancestors, and the love of mechanics that was only second to my love of nature, the inventive propensities that had found earlier vent in the manu-

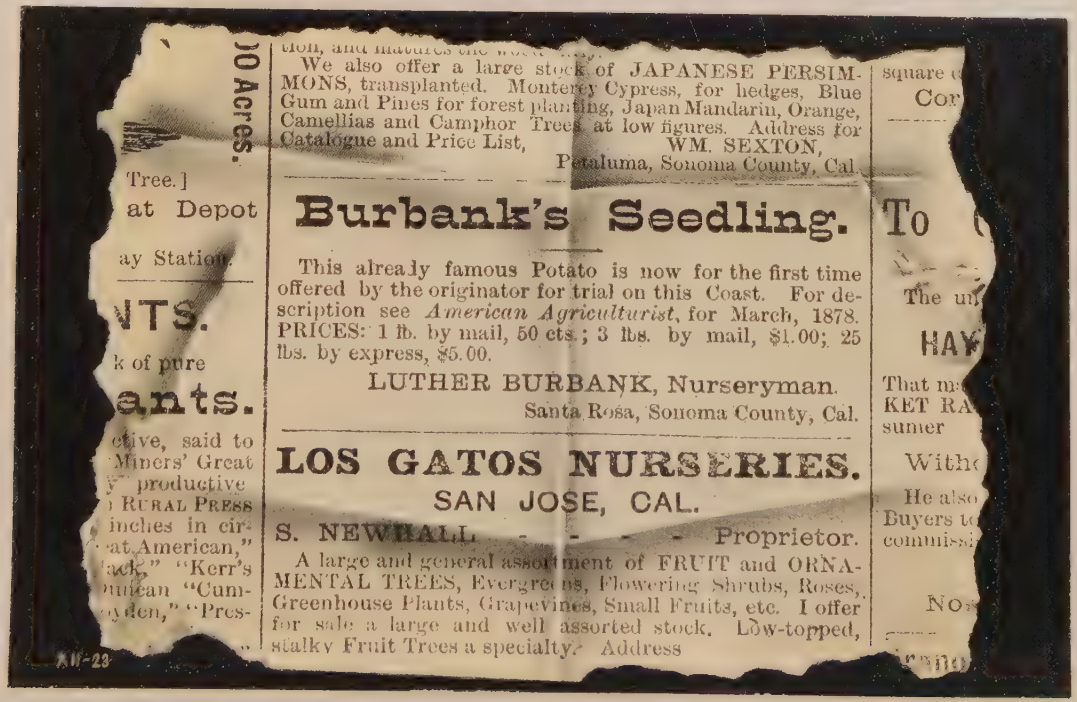
facture of steam engines and new turning devices were to be applied to the plastic material of the living plant.

Just where it all might lead no one could say. The field I was entering had been but little developed, but to my aroused imagination it seemed a field of picturesque possibilities.

Meantime, of course, it was necessary that I should gauge my enthusiasms in accordance with the practicalities. I must make a living. So I purchased a seventeen-acre tract of land in the village of Lunenberg and began to raise garden vegetables and seeds for the market.

Something of the practical success achieved has been suggested here and there in connection with accounts of later plant experiments. In particular, it may be recalled that I found ways of cultivating sweet corn to meet the demands of an early market; and it may be said that in general my garden products were of exceptional quality.

Something has been said also as to the hybridizing experiments that were performed from the outset, including in particular the work with corn and with various races of beans. The experiments were by no means confined to these plants, however. I was like an explorer in a new and strange land full of inviting pathways and alluring vistas. I undertook to experiment in this direction and



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Luther Burbank's First Advertisement

When Mr. Burbank first came to California, he brought with him a few specimens of the Burbank potato. These were multiplied for two or three seasons, and then offered for sale "for trial on this coast." The success of the "trial" is evident in the fact that whole regions of California and Oregon are now given over to the exclusive growing of the Burbank potato.

in that, giving every moment of spare time to the work of investigating the mysteries of plant life.

Every plant in the garden and every shrub and tree and herb in field or woods was scrutinized now with new interest, always with first thought as to its tendency to variation. Where I had casually noticed before that individual flowers of a species differed in details as to form or color or productivity, accurate notes were now made of such variations and the query was raised as to whether they gave suggestion of the possibility of developing new races under cultivation.

Some of the early experiments were full of interest, and the knowledge gained through making them laid the foundation for later successes in plant development. But I had not proceeded far before it seemed clear that such experiments as were contemplated could not be carried out to best advantage in the climate of New England. My thoughts turned to California, whither two of my half brothers had gone many years before. What was reported of the climate of the Pacific Coast region suggested this as the location where such experiments as were planned might best be carried out.

And when the first conspicuous success in the development of a new race of plants had been achieved, through the production of the Burbank

potato—with the story of which the reader is already familiar—I determined at all hazards to move to California. With the taking of the practical steps that followed that determination, in the year 1875, a new epoch of my life began.

—I desired to deal with the forces of life, and to mold the plastic forms of l i v i n g organisms—rather than to spend my life in classifying the fixed and immutable phenomena of dead organism.

A View at Santa Rosa

At the right, Mr. Burbank's present residence; at the left, a seed house, tool shop, and conservatory. Note the boxes and implements piled methodically about the latter. The spineless cactus seedlings are a typical feature, as they occupy a relatively large amount of space in the Santa Rosa gardens.

Luther Burbank—The Early Years in Santa Rosa

The Period of Bitter Struggle

WITHIN sixty days of the time when the definite decision to go to California was reached, I had sold my personal property and closed out my business at Lunenburg.

The business habits that my father had inculcated had been so systematically followed that there was little difficulty in closing up accounts. The total amount of sales was found to be within a few cents of the amount of my annual appraisement. But, although I had been fairly successful in the gardening enterprise during the three years that it had been under way, so much money had been spent on improvements that there remained but a small balance to my credit. At the moment, nothing could be realized on the farm. So in starting for California I was entering on a new field, backed by very little capital.

Meantime the celebrated Ralston failure

occurred, an event which every old Californian remembers but too well. So depressing were the reports of conditions in California that then came to us that friends urged me to change my mind about going there. I had finally decided, however, and had made every preparation, and was not to be deterred.

Not feeling able to pay for a sleeping berth, which at that time was a rather unusual luxury, I was obliged to make such shift as I could to gain snatches of sleep. And I retain very vivid recollections of the discomforts of the trip.

It is curious how some minor incident will linger in the memory when many relatively important ones are quite forgotten. For example, I recall that when on rare occasions I had an entire seat to myself, and would thus be able to curl up on my side to gain a little sleep, the trainmen seemed always to be hurrying through the car and perpetually colliding with my projecting feet. And there is scarcely an incident of the entire journey that is more vivid in my memory than the recollection of this trivial discomfort.

A generous lunch-basket had been provided, and this served its purpose well, for the train was sometimes delayed for an entire day far out on the plains with no house in sight. Several times I had the pleasure of sharing my lunch with fellow-

Another View in Mr. Burbank's Gardens

This picture gives a very good idea of the way in which every inch of ground is utilized in Mr. Burbank's garden at Santa Rosa. Note, however, that the beds are sharply delimitated by board-borders, and that there is evidence of orderly arrangement,—profusion of plants of many species, but quite without confusion

passengers who would otherwise have suffered hunger.

At that time it was not an uncommon experience for axle boxes to become heated by friction, and then it would be necessary to make long stops until repairs could be made. This, with numerous unclassified delays, made the journey longer, but perhaps not more unpleasant than was expected. At best, at that time it took nine days to cross the continent, and the contrast between the trains of that period and the luxurious expresses of to-day is notable.

Early Days in California

An inventory of my belongings on arriving at last in California would have shown very little except clothing, books, and garden seeds, and ten Burbank potatoes that Mr. Gregory had allowed me to keep when he purchased that vegetable. So it was necessary to find employment at once.

I have said that two older brothers were living in California. But I did not go to Tomales where they lived, because it appeared that this region, being close to the ocean, had a climate that was not well adapted to my experiments. I had been advised of conditions by letter, of course, from time to time, and had also read such books and articles dealing with California as could be found, so I had rather clear notions as to what to expect.

I had hesitated between San Jose and Santa Rosa as the location best suited to my purposes, and had decided on the latter place. It has sometimes been thought that my work might have been carried on to better advantage if I had settled in the larger town of San Jose, that being in the midst of a great fruit-producing region; but, on the whole, as elsewhere recorded, I have had reason to be satisfied with the choice that was made.

In that day, however, Santa Rosa was but a small village, offering comparatively few attractions. It had not even a sidewalk. There were no vineyards, no orchards, no ornamental trees. There were wheat fields in the surrounding country, and these gave opportunity for work in the summer with harvesting and threshing crews. For the rest, about the only available employment was the driving of teams of oxen or mules in breaking the soil with gang-plows.

Unfortunately my physical strength was not adequate to either of these tasks. So I found myself almost without means, in a strange land, far from home and friends, and there was no obvious way in which to enter on the specific work that was contemplated. For a time it was even difficult to earn enough to meet immediate needs.

It was necessary to give up all thought of entering immediately on the work of gardening.

Strange Bedfellows

Here are some slabs of a new variety of spineless cactus that Mr. Burbank wished to test by themselves, where they could be readily observed and given special attention. A space in this bed of rare bulbous plants, where some specimens that have been found wanting were weeded out, gave just the desired opportunity. Strange bedfellows, perhaps, but neither plant will interfere with the other.

For the time being I must seek work wherever it could be found, and do any odd job that offered. I recall that on one occasion I heard that help was wanted on a building then in construction, and on applying was promised a job if I would furnish my own shingling hatchet. I spent my last dollar in purchasing one, and on returning found to my bitter disappointment that the job had been given to another applicant.

This was but one of a good many episodes that were well calculated to dampen enthusiasm, and cause me to question whether I had acted wisely in leaving New England. Yet I doubt whether I ever regretted my decision. For the spirit of dogged persistency and of obstinate effort in the face of difficulties is a heritage that the pioneer breed of New England transmits almost unfailingly. Whatever the son of Puritan ancestors may lack, he is almost sure to have a full endowment of the basal instinct of sticking to it.

There were times, however, when, whether or not the spirit faltered, my physical constitution was in jeopardy. In the fall of 1876, I secured work in the nursery of W. H. Pepper, at Petaluma —one of the first nurseries in California, established in 1852—where I worked throughout the winter and into the following spring. Here I occupied a room over the steaming hothouse at

night, and worked in a damp soil by day, until my strength gave out, and I was stricken with fever and returned to Santa Rosa very ill. But for the kindly ministrations of a good neighbor who, seeing my need, furnished me fresh milk without hope of reward, it is doubtful whether I should have pulled through. These were indeed dark days.

The Land of Promise

Yet even in this time of trial I was not for a moment oblivious to the natural advantages and beauties of the country to which I had come, notwithstanding the inhospitable reception. Letters of the period, as preserved by my mother and sister, are filled with enthusiasm over the marvels of the new land. I may quote one of these letters as showing the impression that California made on me, and the opportunities that it appeared to offer for carrying out my treasured project, if ever means could be found to make a beginning.

"Santa Rosa is situated," I wrote, "in a marvelously fertile valley containing one hundred square miles. I firmly believe from what I have seen that this is the chosen spot of all the earth as far as nature is concerned. The climate is perfect; the air is so sweet that it is a pleasure to drink it in; the sunshine is pure and soft.

"The mountains which gird the valley are lovely; then the valley is covered with majestic

A Santa Rosa Tangle

Viewing such a tangle as this, one would hardly suspect that the ground out of which it grows was considered absolutely worthless at the time when Mr. Burbank purchased it. It was a soggy adobe, in which nothing would grow. But drainage, fertilization, and cultivation have transformed it, until there are no more productive acres anywhere on the earth's surface, or at all events in the temperate zone.

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oaks placed as no human hand could arrange them for beauty. I cannot describe it. (I almost cry for joy when I look upon the lovely valley from the hillsides.)

"California's gardens are filled with tropical plants, palms, figs, oranges, vines, etc. Great rose trees, thirty feet in height, loaded with every color of buds and blossoms, in clusters of twenty to sixty, like a cluster of grapes (I would like to pile a bushel of them in your aprons) climb over the houses. English ivy fills large trees, and flowers are everywhere.

"Do you suppose I am not pleased to see fuchsias in the front yards, twelve feet high, and loaded with various colors of blossoms? Veronica *trees,* geranium *trees;* the birds singing and everything like a beautiful spring day.

"The sweet Gum tree of Australia grows here seventy-five feet high in five years; it is a beautiful tree. Honeysuckles, snow berries, etc., grow wild on the mountains. There are so many plants more beautiful that they are neglected.

"I improve all my time in walking in every direction from the city; but have seen no place which nature has not made perfectly lovely.

"I took a long walk to-day and found enough curious plants in a wild spot of about an acre to set a botanist wild.

Vegetation of Many Types

Not only is the soil of Mr. Burbank's garden at Santa Rosa enormously productive, but its various parts are adapted to vegetation of various types. By adding sand here and clay there, the character of the soil has been modified, to meet the needs of different kinds of plants; and it may well be doubted whether any other four acres of the earth's surface has grown a greater variety of plants. Certainly no other corresponding plot has grown anything like the same number of species within the same period of time.

"I found the wild Yam which I hunted for so much in Massachusetts, also the yerba buena, a vine which has a pleasant taste like peppermint. (I send you a few leaves.) I also found a nut that no one has seen before (have planted it), and several (to me) curious plants. I mean to get a piece of land (hire or buy) and plant it, then I can do other work just the same."

The intention to hire or buy a piece of land was not realized for a long term of months after it was thus confidently expressed. But the time came, after weary waiting, when it was found possible to hire a few acres. Then, although working at carpentry during the day, I was able to devote the long summer evenings to preparation for starting a small nursery.

I had come to California in October, 1875, and it was not until the autumn of the following year that the start in the line of work that had been planned was thus tentatively made. And even then my time of trial was by no means over. For, as has been said, no capital was available with which to push my enterprise, and it was necessary to feel the way, step by step.

To be sure I could have appealed to my brothers, and they would very gladly have helped me, but I was averse to doing this, both from an inherent sensitiveness about money, which is almost as

Quantity Production

One of Mr. Burbank's hobbies, as the reader is aware, is "quantity production." Full explanation is given in the text of the reasons why Mr. Burbank finds it necessary to raise large numbers of individual plants in order to find material for his selective experiments. But such a picture as this shows that, when the conditions of soil are right, it is not always necessary to use a large space in order to produce a vast number of flowers. "Quantity production" by no means implies the use of a vast acreage. In point of fact, the famous garden at Santa Rosa contains only four acres, and the farm at Sebastopol only eighteen acres more.

universal a New England heritage as the Puritan conscience itself, and because I knew that my relatives, in common with such other people as knew of my project, were skeptical as to the practicality of such experiments in plant development as were contemplated.

Such skepticism was natural enough on the part of practical men, for the things that I hoped to do ran counter to all common experience. To think of changing the form and constitution of living things in a few years seemed grotesque even to many people who believed in the general doctrine of evolution.

It was not generally admitted at that time that the plants under cultivation had been conspicuously modified by the efforts of man.

And even those exceptional botanists who believed that the cultivated plants owed their present form to man's efforts were prone to emphasize the fact that the plants had been for centuries under cultivation, and to question whether the modifications that could be effected in a single generation would have any practical significance.

So it seemed to most people who knew of my enterprise that it was a half-mad project and one that was foredoomed to failure.

Of course I had only enthusiasm, backed by

Mr. Burbank's Back Yard

Mr. Burbank's present residence stands in a small plot of ground just opposite his famous four-acre plot at Santa Rosa. Of course this lot is used also for plant experiment. This is a view in the rear of the house in the summer of 1914. It is pretty obvious that no space is wasted in this accessory garden.

the tentative results of early experiments in Massachusetts, to offer in response to such criticisms. So it seemed best to trust to my own resources, so far as possible, and prove my case according to my own method.

I would not be understood, however, as saying that my brothers did not give me friendly co-operation. On the contrary they were, as suggested, ready to extend a helping hand, and their aid was sought at the outset in the matter of the propagation of the Burbank potato, the ten tubers of which constituted, in my judgment, my most important tangible asset.

The ten potatoes were planted on my brother's place; and the entire product of the first season was saved and planted, so that by the end of the second season the stock of potatoes was large enough to offer for sale.

The sale of the Burbank potato helped out a little, but did not at first bring a large return. Notwithstanding the very obvious merits of this potato, time was required to educate people to appreciate it. They were accustomed to a red potato, and a white one, even though larger, smoother, and more productive, did not seem at first a suitable substitute. But in the course of time the Burbank potato made its way, as has elsewhere been related, until it became the leading

A Bird's-Eye View

This is a very characteristic view of a half-acre plot or so in Mr. Burbank's garden at Santa Rosa. Note the astonishing variety of plants grown in this small space; but note also the orderly arrangement of the beds, and the general evidences of thrifty gardening.

potato of the Pacific Coast. Long before this, however, I had ceased to grow the potato. It was only during the first few years, before its cultivation became general, that I could profitably grow it for seed purposes.

For the rest, I began my nursery business at Santa Rosa by raising such fruits and vegetables as gave promise of being immediately acceptable to the people of the vicinity. At that time the possibilities of California as a fruit center were for the most part vaguely realized, and it was first necessary to educate the Californians themselves to a recognition of the fact that in the soil and climate of their state were the potentialities of greater wealth than had ever been stored in the now almost depleted gold mines.

Once that lesson had been learned, there would be no great difficulty about disposing of the fruit, for the railways either built or projected insured facilities for transportation.

As to the latter point, however, the conditions were very different from what they now are. The refrigerator car had not come into vogue, and the possibility of transporting fresh fruits across the continent at a reasonable cost seemed remote. So it was natural that such fruits as the prune and the olive were the ones that chiefly attracted attention. Their product could be transported any-

Midsummer at Santa Rosa

Not fewer than a score of totally unrelated species of plants are growing in the small plots of ground covered by this photograph. The tall plants near the center of the picture are hybrid forms of teosinte, the ancestor of the familiar corn plant. In the immediate foreground, clusters of the inevitable spineless cactus.

where, and there was an established market that was practically inexhaustible.

But, as already intimated, the region about Santa Rosa at the time of my coming was pre-eminently a wheat country, and the farmers in general were far more interested in cereals than in fruit of any kind. It was only after the wheat crops began to fail, through exhaustion of the soil for the special nutrients that this cereal demands, that the thoughts of the farming population in general could be directed toward fruit culture.

It is necessary to make this explanation because nowadays everyone thinks of California as pre-eminently a fruit country; and so it would not be obvious, without this elucidation, why one could not start in the nursery business at Santa Rosa, in the year 1876, and hope for immediate patronage and a reasonable return for his labors.

But even if the market had been more certain, it would doubtless have been difficult for me to get a start, because fruit trees cannot be brought to a condition of bearing, or even to a stage where cions for grafting are available, in a few weeks. And I had neither capital nor credit, being virtually a stranger in a strange land.

So it was necessary for me to continue to gain a livelihood by working at carpentry, in which vocation I had now established a sufficient repu-

Another Midsummer's View

This is a view across the center of the main Burbank garden at Santa Rosa, with Mr. Burbank's house (which is really situated across the street) at the right. The tree with heavily massed foliage towering above the building at the left is the hybrid elm which Mr. Burbank brought from Massachusetts.

tation to insure me pretty steady work. But every cent that I could earn, beyond the barest cost of maintenance, was put into stock for my prospective nursery; and, as has been said, the evening hours after the day's work with the hammer was over were devoted to the culture of seedlings.

The tedious and almost disheartening character of the task of establishing myself as a practical nurseryman at Santa Rosa may perhaps be illustrated about as tangibly as otherwise could be done by the citation of memoranda from old account books, which show that the total sales of nursery products in 1877, the first year that my nursery was supposed to be in operation, amounted to just $15.20. The products that brought this munificent return are listed as "Nursery stock and ornamental and flowering plants."

The following year, 1878, the total return from the nursery sales was $84.

The third year the sales amounted to $353.28. The fourth year they came to $702. And it was not until 1881, when the nursery had been for five years in operation, that the aggregate returns from the sale of its products of all descriptions passed the thousand dollar mark. The specific figure, in 1881, was $1,112.69.

The figures thus baldly presented tell their own story. They show that the nursery business in

Cactus, Canna, and Grasses

Here are some flower beds close beside the conservatory building, showing the usual wide range of species. A systematic botanist would place the plants very differently; but Mr. Burbank purposely separates plants of closely related species, to avoid the danger of accidental cross-pollenation.

California thirty-five years ago was in far different condition from what it is to-day. And it does not require much imagination to connect with the figures a story of hardship and privation, and of unrewarded effort, that spelled discouragement for the would-be plant developer.

Yet, on the other hand, the figures are susceptible of a more cheerful interpretation. If we regard percentages, instead of aggregate dollars, it will at once be manifest that the record shows steady progress with a cumulative tendency. Eleven hundred dollars is not a large return for the output of a nursery, but it is a relatively tremendous advance on $15. And when I add that the return for the succeeding year went forward again by about 300 per cent., it will be clear that my efforts were fast gaining recognition, and that the foundations were being laid for a thoroughly successful nursery business.

Not to dwell exclusively on the darker side of the picture, let me say that within ten years the quality of the trees and the reliability of the stock in general of the Burbank Nursery had become so widely known that I was selling more than $16,000 worth of stock per year. In the light of this ultimate prosperity, the privations of the earlier years may very well be minimized, even though they cannot quite be forgotten.

Another View of The Famous Elm

The picture gives another glimpse of the garden at Santa Rosa in midsummer, with the heavy foliage of the hybrid elm much in evidence. In the foreground, the usual striking variety of plants of unrelated families.

Santa Clara County
Free Library
San Jose, Cal.

There are many incidents of that early period of probation, when I was struggling to establish myself as a nurseryman, in order that ultimately I might take up my scheme for plant development on a large scale, that would have a measure of interest and would not be without importance in their bearing on my later work. But I content myself with the narration of a single incident, partly because it has to do with an event that was at the time of momentous importance to me, inasmuch as it gave me a much needed monetary return, and at the same time served to advertise my work; and partly because it illustrates in detail the possibility of rapidly laying the foundations for an orchard, and hence may be of value to some would-be plant experimenters.

Twenty Thousand Prune Seedlings

The incident in question has to do with the production of twenty thousand prune trees, well rooted and ready to transplant for permanent location in an orchard, in a single season.

It was in the fourth year of my attempt at the development of a nursery business at Santa Rosa —that is to say, in the season of 1881—that I produced the twenty thousand prune trees in response to a "hurry order," and in so doing fortified a reputation for reliability and resourcefulness that my earlier work had begun to establish.

Early Autumn at Santa Rosa

Visitors who have heard that Mr. Burbank never carries on fewer than three thousand different experiments at a time, are sometimes astonished to find that the gardens at Santa Rosa are of relatively small size. This picture, taken in connection with those that precede and those that follow it, enables any one clearly to understand how a large number of very elaborate experiments in plant breeding may be conducted on a very small plot of ground.

The order for twenty thousand prunes was given by Mr. Warren Dutton, a wealthy merchant and banker of Petaluma, and later of San Francisco, who had conceived a sudden interest in prune-growing and wished to undertake it on a large scale wtih the least possible delay. Mr. Dutton had seen something of my work, and he came to me in March, 1881, and asked if I could furnish him twenty thousand prune trees ready to set out the coming fall.

At first thought I was disposed to answer that no one on earth could furnish twenty thousand fruit trees on an order given in March for delivery in the fall of the same year. But, after thinking the matter over for a few minutes, I decided that the project was not quite so hopeless as it seemed.

If almond seedlings were used for stock, and prune buds June-budded on these stocks, the thing might be accomplished.

Mr. Dutton agreed to furnish what financial aid was needed during the summer to pay for help and to purchase the required number of almonds for planting. So the bargain was closed, and I entered on the task with enthusiasm. What made the project seem feasible was the knowledge of the fact that almonds, under proper conditions, sprout almost at once like corn, unlike nearly all

Over the Strawberry Bed

At the left, the selected strawberry plants that remain after the bed has been thoroughly thinned. In the middle ground, a bed of teosinte. In the background, the hybrid elm and the Chilean pine with which other pictures have made us familiar.

other stone fruits. I estimated that if almonds were secured at once, and bedded in coarse sand for sprouting, they would furnish seedlings that could be planted in nursery rows in time for June budding.

There was no difficulty about securing the almonds for planting, so the enterprise was almost instantly under way. In addition to the two acres of land which were then available in my nursery, I rented five additional acres; and a large number of men were engaged to plant the almonds in nursery rows as soon as they began to sprout.

The almonds were spread on a well-drained bed of creek-sand and covered with coarse burlap cloth, which in turn was covered with a layer of sand about an inch in depth. In this way we could examine the almonds without any trouble, by lifting one end of the cloth.

The seeds commenced to sprout in less than fourteen days. Those which sprouted were carefully removed and planted in the nursery rows; the others were covered again, and each day more and more would be found sprouting.

The almonds were planted about four inches apart in the rows, the rows about four feet apart, on a piece of land adjoining the creek—a plot now covered with fine residences, and known as "Ludwig's Addition".

At the Height of The Season

Yet another plant-tangle beside the greenhouse at Santa Rosa. Note in the foreground the pile of cactus plants, gathered for transplanting,—some of them doubtless to be shipped to distant parts of the world.

They began showing growth above ground in a short time, and the ground was very carefully cultivated.

By the time the buds in my prune orchard were ready for grafting, the young almond-trees were also ready. Toward the last of June, and in July and August, a large force of budders were employed in placing the French prune buds on the almond-stalks.

After about ten days, when the buds had thoroughly united with the stalk, the tops of the young trees were broken over about eight inches from the ground; great care being exercised not to break them entirely off, but only to break the top down and still keep it alive.

If the top is broken or cut entirely off, the young trees are about certain to die. This is a mistake which many nurserymen make in trying to grow June buds, but by bending the tops over and leaving them on, none of the trees die, and the buds start much better than by any other plan.

Soon the young prune buds began to burst forth. These were carefully tied up alongside the stalk, and when they were a foot or more in height the old almond top was wholly cut away.

By December first, about 19,500 of the trees were ready for the planter; the others were furnished the next season.

Mr. Dutton was greatly pleased, as he had been told by all other nurserymen that it was impossible to produce trees in eight months, and he was very anxious to get a prune orchard at once. By systematic and energetic work we were able to meet his exceptional needs. Never before or since, I believe, was a 200-acre orchard developed in a single season.

Success at Last

As suggested, the feat of producing the twenty thousand prunes served to advertise my work locally. Meantime the reputation for dependableness of the Santa Rosa nursery products had been greatly extending, in a very modest way to be sure, yet with cumulative effect.

Also the general knowledge that prunes constituted a profitable crop was spreading, and about this time the demand for prune trees became very great. Naturally my reputation as a producer of prune stock was enhanced by the demonstration given with the twenty thousand young trees. Prunes that had been grown in smaller lots gave equal satisfaction to purchasers in various regions. Great pains had been taken that no tree should leave my nursery that was not exactly true to name, and in all respects precisely as represented. And now I began to reap the benefits of the reputation thus established.

Across the Cactus Field

A large part of the four-acre garden at Santa Rosa is now given over to the different varieties of spineless cactus, still undergoing observation and development. The picture shows only a small part of the cactus, but gives a rather startling impression of the amount of work involved in the cactus experiments.

Year by year the reputation of the Burbank Nursery spread, until people were coming from a hundred miles or more away, and the number of would-be purchasers was so great that sometimes there was quite a crowd of them in my dooryard waiting their turn.

The quest of prune trees became such a hobby that it came to be the current jest when anyone was asked for to respond: "Well, if you do not find him in town, you will probably find him at Burbank's Nursery waiting for some trees."

In course of time more land was needed, so I purchased the four-acre place in the very heart of Santa Rosa which was in future to be my home and the seat of many of my most important experiments.

This place, which has since become so well-known, was then a neglected, run-down plot which had been on the market for many years. The land was about as poor as could be found. Many attempts had been made to cultivate it, but a crop had not been grown upon it for a long time.

Such a plot of land did not seem to offer great inducements for a nurseryman. But I had a plan in mind that I thought would transform it.

My first move was to place tiles under the whole tract at a depth of four feet, thus draining the land which had at one time been the bottom

of a pond. At the same time the ground was carefully graded. Then, as manure was cheap near by, I had 1,800 loads of it put on the four acres. The manure was spread so thickly that it was impossible to plow it under without the aid of several men, who followed the plow and pitched the manure into furrows as the plowing proceeded.

Further details as to the method of tillage and the preparation of the soil have been given in an earlier chapter and need not be repeated here. But I advert to the subject because I wish to emphasize the possibility of transforming very poor land into land of exceptional fertility. The would-be plant developer who has small financial resources may take a lesson from this experience, and let ingenuity take the place of money.

To what extent intelligent manipulation of land may be rewarded is illustrated in the immediate sequel. For in the spring following the season in which the new land was tiled and fertilized, it was planted to fruit trees, and the year following enough nursery stock was sold from half the land to pay for the entire place and all the improvements that had been made.

So I had a four-acre plot of the finest land, located near the business center of Santa Rosa, that had been paid for with ingenuity and knowledge without making any drain on my purse.

Cactus Plants of the Newest Generation

The cactus seedlings in this bed are the best examples of spineless cactus of the most recent generation, — except, indeed, those that have broken soil in the present season. It will be some time before these plants reach the fruiting age, but Mr. Burbank believes that some of them will then bear fruit that is entirely s p i n e l e s s. The slabs themselves are of course already as smooth as could be desired.

This same plot of land, modified in places by treating with sand to make it suitable for raising bulbs, has doubtless grown a greater number of varieties of plants from regions near and remote than were ever elsewhere grown on any four acres of the earth's surface.

The Long-Deferred Project

By about the year 1884, then, I was thoroughly established with a nursery business that gave me a sure income of ten thousand dollars or more per year, and nothing more was required than to continue along the lines of my established work to insure a life of relative ease and financial prosperity.

But nothing was farther from my thoughts than the permanent following of the routine business of the nurseryman. At no stage of the work in California had I given up the expectation of devoting the best years of my life to plant experimentation and the development of new races of useful fruits and vegetables, and of beautiful flowers. And now the time seemed to have arrived when the long-deferred project could be put into execution.

So from the very hour when my nursery business had come to be fully established I began laying plans for giving it up.

The practical work in the nursery itself had,

of course, furnished a most valuable schooling. I had learned the technique of growing seedlings, and grafting, and the general routine of practical plant culture. And this obviously was knowledge of a kind that would be of inestimable importance when I came to deal with rare exotics and with new forms of plant life. The practical knowledge of how best to nurse a tender seedling has had its full share in the furtherance of the successes of later years.

Meantime, I had gained a comprehensive knowledge of the native plants of California, through having collected their seeds and bulbs for Eastern and foreign seedsmen.

At about this time there was an interest in the native plants of California, and many nurserymen were anxious to give them a trial. During those years when my own nursery business was only formative I eked out an income—in intervals of carpenter work—by gathering seeds and bulbs on orders from various Eastern and foreign firms. In the course of this work I made various trips to the surrounding territory. On two occasions, in 1880 and in 1881, I visited the region of the geysers, which was found to be a productive locality for new material. And everywhere I went careful study was made of the vegetation, both with an eye to the immediate collection of seeds and bulbs,

At the End of the Conservatory

Here the camera has been shifted to take in the flower beds at the end of the conservatory, with the hybrid elm still in the middle ground. Visitors are usually surprised at the small size of Mr. Burbank's greenhouse, but they soon learn that the greenhouse, although by no means unimportant, plays but a relatively small share in the work of plant development at Santa Rosa. Myriads of seedlings are started in the greenhouse, but very few of them remain there beyond the kindergarten period.

and for future reference in connection with the projected work.

The knowledge thus gained served well in later years in suggesting material for hybridizing experiments.

Moreover, the work of collecting, preserving, and shipping seeds, plants, and bulbs taught practical lessons that were of infinite importance later in the instruction of my own collectors in foreign lands, who gathered the materials that had so large a share in the production of new plant forms that finally appeared in my experiment gardens.

I should have loved dearly to extend the botanizing explorations to still wider territories, and after my nursery business had come to be fully established, about the year 1884, it would have been quite feasible to do so.

The work was so organized that it might readily have been left to assistants for periods of a year or more, during which I could have traveled all over the world and observed for myself the plant products that seemed to invite importation.

But to have done this would have been to break in on the plan of the projected life work that had already been to some extent interrupted for a period of about eight years, during which I had found it impossible to carry out new experi-

ments, except on a limited scale, and in intervals of arduous practical duties. Longer delay was not to be thought of. I was eager to take up the projected work, and it was not deferred for a season longer than was absolutely necessary.

Even before I could see my way to the abandonment of the practical work of the nurseryman, projects were in hand that were preparing the way for the new activities. In particular, I had sent to Japan to secure seeds and cuttings of a great variety of fruits. It seemed certain that I could better afford to hire collectors in foreign lands to secure material than to go to foreign lands in person in quest of it.

The first consignment of Japanese seeds and seedlings reached me November 5, 1884. In preparation for their coming I had purchased the Dimmick place and prepared my experiment grounds a few months earlier. And when the consignment was in hand, with the representatives of exotic species of fruits, I felt that a new era had begun for me, and that the long frustrated plans were about to find realization.

The following year, so well had the nursery business prospered, I was able to purchase a farm at Sebastopol, seven miles away from Santa Rosa, where the conditions were more favorable for the growing of some types of plants.

Tropical Luxuriance

Partly because of the richness of the soil, and partly because of the climate, but largely because of the choice selected varieties of the plants themselves and the special attention that they receive, the plants at Santa Rosa grow in truly tropical luxuriance. Old residents who remembered the present Burbank gardens when the spot they now occupy was an arid, desert-like area, must rub their eyes when they view such a scene as that here depicted. No one who witnessed this transformation is likely ever again to pronounce any soil worthless. Regulate the conditions of moisture and aeration properly, and almost any soil becomes productive.

The second consignment from Japan, including the plum, whose story has elsewhere been told in detail, came Dec. 20, 1885. The place at Sebastopol where they were to be planted and nurtured was purchased eight days later. And with this purchase the project of devoting a lifetime to the work of plant experimentation was fairly and finally inaugurated. For the Sebastopol place, with its eighteen acres, was not purchased for use as a practical nursery, but solely as an experiment garden.

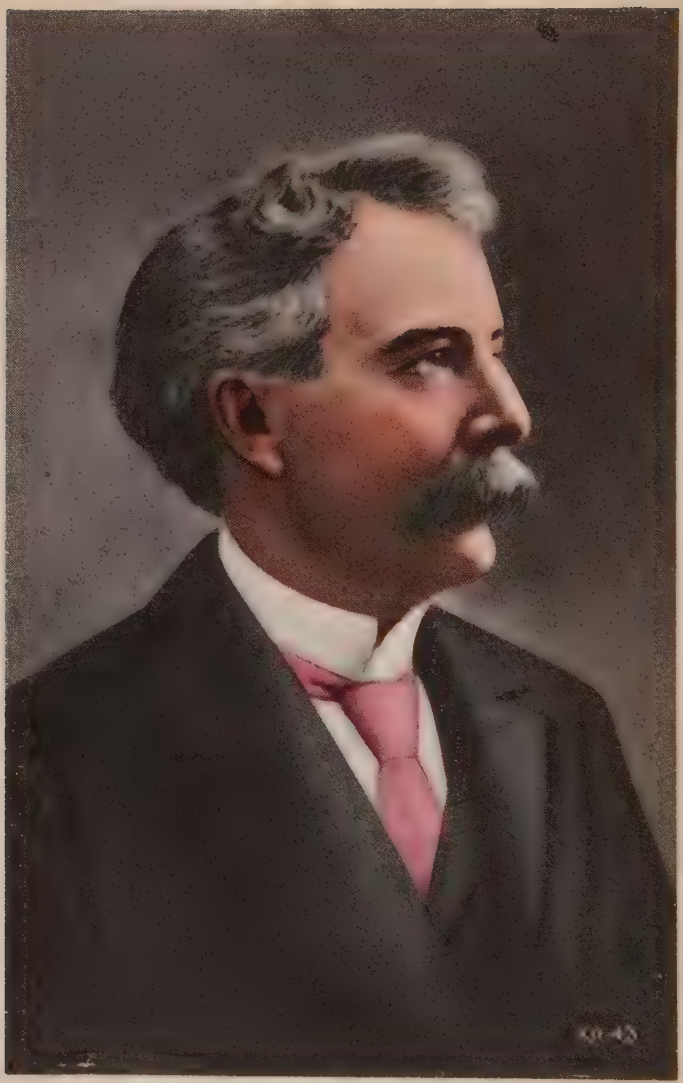
With the development of the Sebastopol place, a new phase of lifework began.

Thenceforward my time was divided between the experiment garden at Santa Rosa and that at Sebastopol, and upon one place or the other all my experiments in plant development were to be performed.

An interest in the nursery business was retained for two or three years more, to give money to carry out the initial stages of the new experiments; for of course it could not be expected that new varieties of fruits and flowers would spring into existence in a single season. Nor could instant purchasers be found for them if they had been thus magically produced. But from the time when the place at Sebastopol was purchased, the die was cast, and it was determined in future my

energies were to be devoted to the work of plant development—the work that had been projected, and at which a beginning had been made back in Massachusetts, and the hope of continuing which had been the incentive to persistent efforts during the period of stress and privation.

—An inventory of my belongings on my arrival in California would have shown very little excepting clothing, books, garden seeds and ten Burbank potatoes that Mr. Gregory had allowed me to keep when he purchased that v e g e t a b l e.



Luther Burbank at the Age of Fifty

Thanks to good heredity, abstemious habits, and out of door living, Mr. Burbank was a young man at fifty, as this picture will testify. Although seemingly of rather delicate physique, he has always enjoyed a large measure of good health, and his supply of working energy is unlimited.

Luther Burbank—His Patience Rewarded

The Period of Great Achievement

THE purchase of the farm at Sebastapol was made, as recorded in the preceding chapter, on the 28th of December, 1885. As this was to be the important testing ground for the chief companies of my trees and flowers, it may perhaps be of interest to describe somewhat in detail the farm itself and its topographical surroundings. In particular an idea should be given of the indigenous flora of the region, because many of the wild species were utilized in experiments of great interest and sometimes of importance.

The picture thus presented of the environment of the work will serve, perhaps, to give a clearer understanding of some of its details.

The plot of land at Sebastopol was known at the time of its purchase as the Gold Ridge farm, and that name has been retained, although the place has usually been referred to in the preceding

pages merely as the experiment farm at Sebastopol.

The farm has a gradual and gentle slope toward the Santa Rosa valley. It is undulating in contour, and its chief slopes face the east. The soil is sandy, no doubt part of one of many great sand dunes piled up by the waves of the Pacific Ocean and the winds in past ages.

On this place there is a great variety of soils and of degrees of moisture. Some parts of the land are so moist that the water seeps up to the surface throughout the season, and the remainder is so loose and friable that moisture may be found all through the summer even six months after any rain has fallen upon it.

Native Plants

At the time the place was purchased about two-thirds of it was covered with white and tan oaks, the native Douglas spruce, manzanita, cascara sagrada, hazel and madrona, while beneath the trees grew brodiaeas, calochortus, cynoglossum, wild peas, fritillarias, orchids, sisyrinchiums—yellow and blue—and numerous other wild plants and shrubs.

During the first few years following the clearing away of this forest many species of clover wholly new to me made their appearance, probably in all nearly or quite twenty species. There

Bird's-Eye View at Sebastopol

Mr. Burbank's second and larger experiment farm is located at Sebastopol, seven miles from Santa Rosa. The picture gives a glimpse across the farm, with some orchard trees in the foreground, and with Mt. St. Helena in the distance.

was also an abundance of alfilaria—*Erodium moschatum*—a Chilean plant, belonging to the geranium family. This and the clovers growing in the winter made a splendid crop to turn under in the spring, thus adding to the soil much nitrogen—among the most expensive of all fertilizing materials.

Later, five acres were added on one side of this place, and again three acres on another—of very similar soil—making now eighteen acres closely covered with numerous species of plants and trees used in the various experiments.

This farm is one of the most sightly places in the vicinity. In the middle foreground lies the broad Santa Rosa Valley with the city of Santa Rosa in the distance; and almost under one's feet is Sebastopol. Mount Saint Helena looms up grandly in the east some thirty miles away, more than four thousand feet in altitude. Most of the hills and mountains of the region are wooded with Douglas spruce, various oaks, madronas, and manzanitas. Along the streams, through the valley, grow Oregon maples, alders, ash, willows, and hawthorns.

Looking over the Valley of Santa Rosa one sees one of the most prosperous communities anywhere to be found. In the early spring, great apple and prune orchards lighten the valley with

a sheet of bloom; and later, fields of hops here and there, with the vineyards along the foothills, make a most enchanting view. The floor of the valley is like one great park dotted here and there with giant oaks, each one of a different form; here, perhaps, a hundred in a cluster, there a half dozen, artistically grouped as if by a landscape gardener. These are mostly white oak—though in some parts of the valley there are numerous patches of the black oak—and along the streams the mountain live oak.

In the distant hills north and east are a great variety of evergreen and deciduous trees and shrubs among the most common of which are the following Conifers: the digger pine, sugar pine, the yellow pine, the knob-cone pine, Coast redwood, incense cedar, MacNab cypress, Goven cypress, and nutmeg pine.

Some of the other evergreen and deciduous trees growing in this immediate vicinity are: Oregon maple, box elder, Oregon ash, California buckeye, white alder, red alder, tan-bark oak, white oak, Pacific post oak, black oak, blue oak, maul oak, mountain live oak, tree elder, bush elder, cottonwood, bayberry, madrona, golden chestnut, Coast manzanita, and common manzanita.

There are ornamental shrubs in profusion; among others, the rose bay, Azalea, June berry,

Watsonias at Sebastopol

At Sebastopol there is opportunity for flower beds on a somewhat more expensive scale than at Santa Rosa, as this picture suggests. But we find the same indiscriminate mixture of plant tribes,—in this case beds of Watsonias lying alongside a group of orchard trees.

Judas tree, thornapple, western sweet-scented shrub, California lilac, shrubby lilac, Coast lilac, mahala mats (trailing or creeping lilac), buckthorn, cascara, flowering dog-wood, common dogwood, choke cherry, meadow-sweet, wild apple, burning bush, poison oak, hazel, black willow, creek willow, velvet willow, snow-berry, oso berry, chamissal, and salal.

Of vines and bearers of small fruit or of handsome flowers there are the wild grape, Oregon grape, mahonia, huckleberry, bilberry, low gooseberry, straggly gooseberry, canon gooseberry, flowering currant, compact flowering currant, tree poppy, modest shrub, Labrador tea, redwood rose, California rose, Sonoma rose, silk-tassel tree, bear brush, yerba santa, bush monkey flower, mistletoe, Dutchman's pipe, salmon berry, raspberry and thimble berry.

These glimpses of the indigenous flora of the immediate vicinity of the new experiment farm will serve to give an idea of the abundance of interesting native material, for the most part hitherto quite untouched by the plant experimenter, that awaited investigation.

Anticipations

Had I felt at liberty to follow my own inclinations, paying no heed to the question of practical monetary returns, I could have found abundant

material for the investigations of a lifetime without going outside the bounds of the Gold Ridge Farm itself.

My own tastes would have led me to devote the major part of the time to the investigation of flowering plants and the development of flowers having hitherto unrevealed qualities of form and color and odor. But it was obvious that one could not hope to make a living in this way. I knew that in order to have even a fair prospect of securing a monetary return that would enable me to keep up my work, once the nursery was abandoned, it would be necessary to produce marketable fruits.

In this field alone could one hope to find a ready sale for new plant developments, however striking or interesting from a scientific standpoint the results of experiments in other lines might prove.

And of course the indigenous wildings of the immediate environment offered only scant material for the immediate production of new fruits of practical value. As a matter of course one must depend for material largely on the orchard fruits already under cultivation. These had been educated for countless generations. Doubtless most horticulturists regarded them as perfected beyond hope of conspicuous further development. But in my view what had been done with these fruits

Another View at Sebastopol

Here we are standing beside the road leading from the main gate up to the only group of buildings on the Sebastopol farm. The buildings stand near the center of the grounds, and the weeping birch is a focal figure, comparable to the hybrid elm at Santa Rosa.

might better be regarded as a proof of their capacity for further education.

In particular, I hoped, with the new material then being gathered from foreign countries, to be able to undertake hybridizing experiments that might reasonably be expected to produce altogether novel results.

How fully this expectation was justified, the reader is already aware. But it should be recalled that the things which now seem axiomatic because they have been accomplished had quite a different aspect from the standpoint of the year 1885. Hybridizations that have now been shown to be ready of accomplishment were then regarded as quite impossible by all horticulturists who gave the matter a thought.

Indeed, as has been pointed out, the general attitude among botanists and horticulturists everywhere was one of profound skepticism as to the possibility of developing modified races by hybridizations, or, indeed, by any means whatever within limited periods of time.

My own faith in the possibility of developing new races through crossing and selection had never faltered, however, since my earlier studies had given a clear view of the range of variation of plants both under natural conditions and under cultivation. And it may be taken as adequate

proof of confidence that I purchased experiment farms and sent far and wide for hybridizing material at the very earliest moment when my financial condition made such action possible.

Nor should it be understood that I had by any means entirely neglected experimental tests during the period of my nursery experience. On the contrary, I had at all stages of this experience devoted as much time as I could spare to tests in cross-fertilizing and in selection among the various nursery products. These had served to give an expert knowledge of the results that might be expected from plant improvement.

Moreover, tentative results had been attained that gave support to the most sanguine expectations.

Orchard and Garden Materials

Indeed, it was largely as the result of these experiments in selection that my nursery orchards had come to be of such quality as to command the attention of an ever widening circle of fruit growers.

I dealt with a very wide range of fruit-bearing and flowering plants, and although no new plants had been produced that could be compared with those of a later period, my nursery had been stocked with the very best existing varieties of forty or fifty different groups of fruits and flowers,

A Near View of the Sebastopol Farm House

The large tree this side of the farm house is Mr. Burbank's celebrated cherry, on which four hundred different varieties are grafted. The automobile at the right is the one with which Mr. Burbank makes his trips regularly between Santa Rosa and Sebastopol. He is his own chauffeur, and a very careful driver.

and all had been submitted to careful comparative tests until those that remained were of exceptional quality, and thousands of new productions were under way that were undeveloped.

The nursery catalog issued in 1887—the year before I sold my nursery preparatory to devoting my entire time to the experiment gardens then in an advanced stage of preparation—comprises 24 pages, and preserves the list of the exceptional varieties of horticultural plants that had been selected and developed and supplied the material for continuance and extension of the experiments on a larger scale on the test ground at Sebastopol.

Here were orchard fruits in great variety; small fruits of the choicest types; nuts of several species, including chestnut, walnut, and pecan; garden vegetables, including asparagus and rhubarb; a long list of deciduous ornamental trees and shrubs, and an even longer list of evergreens; vines and trailing shrubs in interesting variety; and elaborate series of roses, hedge-plants, bulbous plants, and bedding plants in general. All these had been collected and selected and prepared for this very purpose.

With such materials at hand, it was obviously possible to continue the work of developing new varieties on an expansive scale so soon as the grounds were ready. Moreover, as we have

already seen, shipments of plants from Japan began to be received even before the Sebastopol farm was purchased.

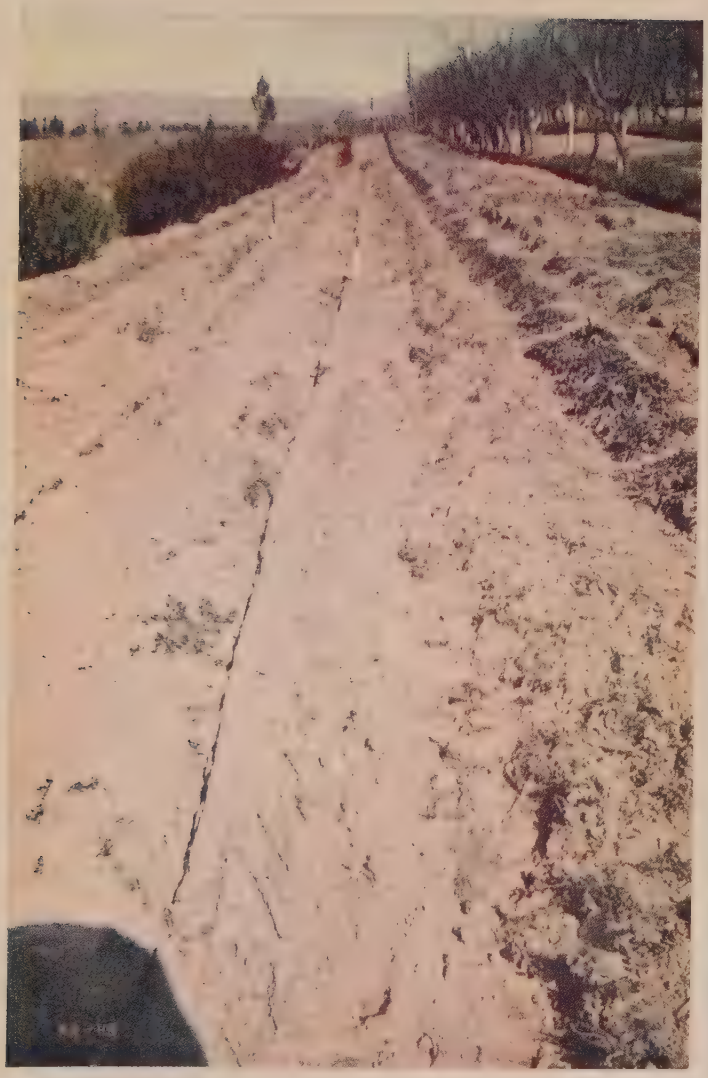
Material from Abroad

The year following the purchase of the farm, grafts of twelve varieties of New Zealand apples were imported. And from this time forward I was constantly in receipt of shipments of seeds or bulbs or cions of rare or interesting plants from all regions of the world.

Association was established with foreign collectors who made a business of securing plants. And as the work became known in the course of succeeding years, amateur collectors everywhere were kind enough to send me materials, so that the experiment gardens became a testing ground for seeds of many thousands of species that doubtless had never before been grown in America.

Much of this is already known to the reader of the early chapters of this work, but the facts are emphasized anew because an understanding of them is essential to the comprehension of the work that was being carried forward.

The very essence of the new method was to bring together, through hybridization, plant strains that had been long separated, making possible the recombination of hereditary factors in such a way as to bring out submerged racial traits.



Days of Preparation at Sebastopol

Here the ground has been carefully prepared, and the seeds planted in the straightest possible rows. Note the label-stakes to indicate different varieties. Note also the length of the rows, in contrast with the more compact flower beds of the Santa Rosa garden.

Obviously such an attempt requires the co-operation of collectors living in widely separated regions. I wish to pay especial tribute to the faithful service that has been rendered both by professional collectors and by amateurs who knew me by reputation only and who had no thought of reward beyond the satisfaction of aiding in a work calculated to benefit humanity at large.

Through these collectors I have frequently obtained wild plants the economic value of which had never been suspected, and which might otherwise have remained unknown, which, when combined with plants already in hand proved of inestimable value in the development of new varieties of great scientific interest or of practical importance.

Often a certain line of experiment has been carried to the point where further progress seemed impossible unless the plant under cultivation could be effectively crossed with some new closely related species. And, curiously enough, just when a new plant was needed—be it plum or blackberry or solanum or poppy or walnut—it seemed always to come from some thoughtful, perhaps unknown collector living in an out of the way part of the world, who appeared to have known by intuition just what were the needs of the moment.

This occurred so often that it came to be a mat-

ter almost of expectation, and so constant and so varied have been the contributions of willing helpers that these expectations have seldom been disappointed.

Among my regular collectors residing in places that have not hitherto been thoroughly botanized, I must name in particular my highly esteemed friend, Senor Jose D. Husbands of Chile, who has sent me almost numberless new species for trial from the southern half of South America.

For me Senor Husbands has scaled forbidding mountain peaks, waded rivers, visited islands, traveled through wild arid deserts, even risking his life among barbaric natives who have never been subdued and who do not always give the traveler hospitable welcome. The value of the materials that thus have been secured would be beyond estimate.

Methods and Objects Sought

To give details as to the methods by which I sought to blend the qualities of the plants that furnished material for the new investigations when the experiment gardens were fairly in operation, would be to repeat what has been fully told in earlier volumes of this work.

The record of the results of these experiments makes up the main bulk of all these volumes. So it obviously is not desirable that I should attempt

Flowering Time in the Sebastopol Orchard

The fruit trees shown in this view include plums, prunes, plumcots, cherries, and apples in endless varieties. The conical-shaped tree in the right middle-ground is a fine specimen of the California chinquapin, a picture of which was given in volume eleven.

to repeat here, even in epitome, what has elsewhere been told in detail. Yet a few general comments on methods and results may be of interest.

Also it may not be amiss, by way of summary, to outline very briefly the chronological sequence of the chief lines of endeavor of the period, now approaching the termination of its third decade, during which the attempt to develop improved races of plants has been comprehensively carried out.

In the successive chapters that have told of the different lines of endeavor, plants were naturally grouped according to their botanical relations or their economic uses, with only incidental reference to the date of the experiment through which this or that particular variety was developed.

Perhaps, then, it will serve to coordinate the work as a whole if we review in partial outline the story of the endeavors of successive periods; bearing in mind, of course, that many scores of experiments were always being carried forward simultaneously, and that many experiments that achieved notable results at an early day, are still being carried forward in the attempt to obtain results even more notable.

Taking the widest and most general view, it may be said that the chief lines of investigation at

the outset of the period when my energies were turned exclusively to experimental work, instead of being unhampered by ordinary nursery duties, had to do with the improvement of orchard fruits on one hand and with certain flowering plants on the other. From the outset, however, small fruits were given almost equal attention.

It had been made clear to me, through nursery experience, that the varieties of fruits grown in California at that time, being all of eastern origin, were not ideally adapted to the new climatic conditions of the Pacific Coast. It seemed desirable that new varieties adapted to the new conditions should be produced.

So one prime object of my early work was to develop orchard fruits, and notably prunes and plums and peaches, that would be of value in the development of the fruit industry in California.

But I had in mind also the desirability of producing fruits that would be adapted to growth in other regions of the country. I observed that most of the fruits then existing were lacking in important qualities that are equally essential wherever the fruit is grown. Many trees, for instance, bore large crops one year or perhaps for two years in succession, and then were practically sterile in the ensuing season. A late spring frost, too much rain at the time of blooming, or some

Crinum Beds—and Others

This is another view across the Sebastopol garden, showing some of the hybrid crinums in the foreground and the orchard trees in the background. The crinums and allied bulbous plants are set out in long rows, and make a very remarkable display in their season.

other less evident cause, might prevent the tree from bearing, thus making fruit raising a somewhat "hit-or-miss" proposition.

I determined from the outset to give particular attention to these matters, endeavoring to produce varieties of fruit trees that would be hardy and resistant to unfavorable conditions and that would be not only heavy bearers but regular bearers. The matter of resistance to insect pests and to disease was also given careful consideration from the outset.

Seedlings that showed susceptibility were ruthlessly weeded out, and the survivors became the parents of races that are relatively immune to disease.

Of course the combination of different species to bring together long-diverged racial strains was a fundamental part of the plan. Unnumbered thousands of hand-pollenizing experiments were made each year, and the limits of affinity between the different species were tested by ceaseless and persistent efforts.

When species that were seemingly somewhat closely related proved infertile after cross pollenation, it was not taken for granted that there was real antagonism between those species until the experiment had been tried over and over in successive seasons, perhaps thousands of times in the

A Briar Patch at Sebastopol

The plants included in this view are quite literally "too numerous to mention." But it will be of interest to note that three or four conspicuous clusters of foliage in the middle ground represent groups of thornless blackberry bushes. These plants take on a vine-like growth, and in many cases the tips of the "vines" have been covered with earth that they may take root and form new plants.

case of a single pair of species, often using different individuals and varieties of the species.

Instances in which a hybridizing experiment at last proved successful after many years of failure—as for example in the case of the sunberry—will be recalled by the reader.

Practical and Scientific Interests Combined

In general, practical results were sought, rather than the establishment of theories; yet for the most part, in such a line of experiment, theory and practice necessarily go hand in hand.

The only sharp distinction between our method and that of an experimenter who is looking only to the investigation of the laws of heredity is that we were obliged to select for preservation a few only among large companies of hybrid seedlings, destroying the rest, and to that extent making the record incomplete.

It would be of great scientific interest to trace the entire company of a hybrid stock as to all its individual members through successive generations.

But when the members of a fraternity number ten thousand or a hundred thousand or a million, as was often the case in our experiments, the attempt to preserve all and to investigate their progeny through several generations would necessitate the expansion of our experiment farm until it com-

prised thousands of acres, and the employment of an army of helpers.

If this is true of the plants of a single series of experiments, what shall we say of the aggregate companies making up the ranks of plants involved in two or three thousand experiments. So soon as our work was well under way, and throughout all the succeeding years, at least three thousand different series of experiments have been carried forward simultaneously.

Very commonly a million seedlings are involved in a single fraternity.

Under these conditions, it will be obvious that there was no choice but to select the few individuals that came nearest to the ideals of a mental forecast, ruthlessly destroying the rest to make room for the favored ones.

And in so doing we were of course duplicating the method of Nature herself, although the qualities that determined our choice in any given case were not usually those that would have fitted the chosen individuals for preservation in a natural environment. Our selections were made, of course, with an eye to fitting the plant to meet human needs and tastes. The selections of Nature are made with reference to the needs of the plant itself.

But if we make allowance for this difference in

Gladiolus Beds at Sebastopol

This picture will give an idea of the extent of the gladiolus experiments. These are conducted almost entirely at Sebastopol, as the character of the soil there is admirably adapted to the growing of bulbs. There are many other things besides gladioli shown in this picture, as a matter of course.

the point of view, we may say that the principle of selection is the same in each case.

And we are justified, I suppose, in saying that the experiments in artificial selection made on my experiment farms during the period under review, constitute the most elaborate series of experimental proofs of the truth of the Darwinian doctrine of Natural Selection that have ever been brought forward.

Such experiments in hybridizing and selection as were part of the every-day work at Santa Rosa and Sebastopol, season after season, involving thousands of species, had been performed elsewhere only in isolated cases and by rare exception. Nowhere else had such a work been undertaken on a comprehensive scale even with a few species of plants.

The application of the method to thousands of species, involving countless myriads of individuals, was an absolute novelty.

Scientific Results

The results of the work in their bearings on scientific theory may be briefly summarized.

These experiments demonstrated that the barriers between natural species are much more fragile than had been almost universally supposed.

They showed that not only may we produce fertile hybrids between a very large number of

related species of plants, but that equally fertile hybrids may be produced by the union of a good many species that are so widely separated as to be classified in different genera.

They showed that the first-generation hybrids may resemble one parent or the other pretty closely or may show a blending of qualities; and that in the second generation, with rare exceptions, there is a segregation and recombination of the racial qualities of the original parent species, in which the extreme forms will more or less closely duplicate one parent or the other, and the intermediate forms may show almost every conceivable gradation between the two.

They showed, further, that it is possible by selecting among the second-generation hybrids the individuals that show any desired combination of qualities, to develop, in the course of a few generations of inbreeding, races in which this combination of qualities is so accentuated and fixed as to constitute a distinguishing characteristic of a new variety quite unlike the original forms.

Moreover, the later-generation hybrids might reveal racial traits that were not observable in either of the parent species.

The segregation and redistribution of characters often gave opportunity for the appearance of qualities that have long been submerged.

Cherries, Plumcots, and Other Orchard Fruits

The picture, besides giving a glimpse of the orchard in blossoming time, shows the extremely attractive character of the Sebastopol landscape in general. There are prosperous farms on every side, and the distant mountain ranges furnish an attractive background.

As a tangible illustration, hybrids in the first generation may show an enhanced capacity for growth, and the later generation hybrids may be graded from groups of dwarfs at one end of the scale to giants at the other. A corresponding gradation may be shown in regard to other qualities, such as color of flower, character of leaf, flavor of fruit, productivity, resistance to disease—in a word as to all the varied properties that go to make up the personality—if the expression be permitted—of a plant.

Many of these things are so well recognized today that they seem mere matters of fact, quite beyond challenge. But they were matters of very ardent challenge in the day when they were first being demonstrated in the experiment gardens at Santa Rosa and Sebastopol.

When the first official announcements of this work were sent forth, through publication of the brochure called *New Creations in Fruits and Flowers* in June, 1893, the measure of the novelty of the announcements may be gauged by the popular interest aroused on one hand and by the outspoken incredulity of the botanical and horticultural worlds in general, save only the individual experts who had previously visited my grounds and seen for themselves the truth of the matters that were now given publicity.

It will serve to give an outline of the progress of the work if we briefly summarize the contents of the successive catalogs in which the new developments were publicly reported.

New Developments Announced in 1893

The first of these, as already noted, appeared in June, 1893, under title of *New Creations in Fruits and Flowers.* The subsequent ones were regarded as supplements to the original publication. By running over the contents of these supplements of successive years, an impression is gained of the sequence in which the more important plant developments were brought to a stage of improvement that justified their introduction. But of course it must not be inferred that the different experiments had been taken up in the precise sequence in which their successful results were announced. Some lines of investigation require far more time than others; there are experiments still awaiting announcement that were begun at the very outset of my experimental work.

Nevertheless the successive announcements may be taken as at least giving a general view of the progress of the work; so we may briefly summarize the contents of the original publication and of the earlier Supplements to which chief interest attaches because of the entire novelty of the products they present.

A Sebastopol Pot Pourri

A small volume would be required to catalog and describe all the varieties of plants shown in this picture. From this point of view by the roadside, the eye glances across endless rows of flowers of a multitude of varieties, and back to the Sebastopol farm house and orchards. Let it be recalled that these flowers are never marketed. They are grown purely for experimental purposes, and those that are not selected for introduction or for the continuance of the experiment are destroyed.

In a later chapter we shall take up the theoretical bearings of the new work. Here we are concerned for the most part with a bald recital of the names of the more important new varieties of plant life, presented somewhat in the order of their introduction. Even as to these, nothing like a complete list will be given, for the minor improvements of plant life, large numbers of which have been referred to in the course of this work, do not call for special reference here.

Even the recital of the names that cannot well be overlooked may carry us to rather tiresome lengths.

The new varieties of hybrid plants announced in the publication of 1893 are listed in 18 successive groups as follows:

(1) Hybrid Walnuts, including the forms afterward named the Paradox and the Royal. The pedigrees of the two hybrids are given, one being a cross between the California and the Persian walnut and the other between the black walnut of the East and the California black walnut; but the distinctive names were given later.

(2) A new Japanese Mammoth Chestnut. The origin of this chestnut is given, and it is stated that the one offered is "the best one of more than ten thousand seedlings, a tree which every season bears all it can hold of fat, glossy nuts of the very

largest size and as sweet as the American chestnut."

(3) Two Quinces named respectively the Van Deman and Santa Rosa, the former named in honor of the Chief of the Pomological Department of the Department of Agriculture, who had particularly admired it. A new Japan quince named Alpha and a new flowering quince named Dazzle.

(4) Plums and Prunes. These comprised ten new varieties of hybrids, for the most part bearing numbers only, but including the Golden, the Delaware, the Shipper, and the plums that afterward were famous as the Wickson and America; also the Giant and Splendor prunes.

(5) Hybrid and crossbred Berries. Here there are 19 new varieties, including the Japanese Golden Mayberry, the Primus berry, the berry afterward named Phenomenal, the Paradox, the Autumn Giant, and Eureka. The strange raspberry-strawberry hybrids are also described and pictured, although not offered for sale.

(6) Seedling Roses and rose hybrids. There are five named or numbered varieties in this list, including the Peachblow and the one afterward known as Santa Rosa. A number of Rugosa hybrids are listed in addition, one of them being mentioned as having received a medal from the California State Floral Society.

Mr. Burbank's New Home in Santa Rosa

It will be recalled that this house appears in the background of several of the Santa Rosa views already shown. It is a substantial, commodious, and highly attractive dwelling, but by no means extravagant. It was built for comfort, and admirably fulfills its purpose.

(7) New Callas. These included the variegated Little Gem, the Snow Flake, the Giant Calla, and the Golden variegated *Richardia albo maculata*, it being recorded of the first-named that it was selected from eighteen thousand seedlings, and of the last named that it was the single selection among hundreds of thousands of bulbs of the spotted-leaved Calla that had been raised from seed on my grounds.

(8) Hybrid Lilies. Only two specified varieties are offered under individual numbers, one being the large-flowering *Lilium pardalinum* afterward known as Fragrance, and the other a dwarf form —growing only ten inches high and producing from 20 to 40 blossoms on each of the short stalks —which afterwards bore the name of Glow. But the names of 42 species and varieties were given as only a partial list of the lilies that had been combined in the hybrid seedlings which even at that time made up an extraordinary colony in the experiment garden.

It was stated that some of the older hybrids and seedlings were represented by as many as a thousand bulbs each; that half a million kinds were yet to unfold their petals for the first time; and that we were still planting from one to three pounds of hybridized lily seed every season.

So the varieties actually announced were only

Mr. Burbank's Porch

Even the flowers that grow beside Mr. Burbank's house are always undergoing observation and being tested as to their capacity for further education. So pictures taken in different seasons do not have the same appearance. At the moment, this beautiful rose has the place of honor as the decoration selected for Mr. Burbank's porch.

the forerunners of a vast company of which more would be heard in later years.

(9) New varieties of Gladiolus. It was stated that six of the best forms of this flower, from among a million or more seedlings raised during the ten years preceding, had been introduced four years earlier, one of these being the first double gladiolus and the first of a type in which the flowers are closely arranged all around the spike, like a hyacinth. In the catalog ten interesting forms were listed and succinctly described, among others a white form with very large flowers, several dwarfs with curious stripes and markings, and sundry double forms.

(10) Hybrid Clematis. Six new forms were named, including a double variety, with broad snow-white petals, the flowers five to six inches in diameter, that blooms almost constantly throughout spring, summer, and fall. Another variety was said to resemble a white water-lily, and it was said of the group that "No hardy flower except the rose and the lily is so magnificently beautiful as the new hybrid Clematis; seedlings of which have been grown at the rate of ten thousand a year for several years."

(11) A new Myrtle. This is described as a new silver variegated Roman Myrtle or Brides' Myrtle, originated as early as 1882. It had been

Another View of Mr. Burbank's Porch

At this end of the house, an ivy is at present in favor, and will perhaps form a permanent attraction. It is a very beautiful selected specimen, as will be seen.

characterized by the California State Gardener as the handsomest variegated shrub he had ever seen.

(12) A new Poppy named Silver Lining. Described as developed by six years' selection from a sport of the *Papaver umbrosum* (Butterfly Poppy), and as being of a glistening silver white on the inside of each petal instead of crimson and black; the outside remaining of the original brilliant crimson, thus producing a strikingly beautiful effect.

(13) A new plant, the Nicotunia. This name had been coined to describe a new race produced by crossing a tobacco plant (*Nicotiana*) with a Petunia. A suggestion of the difficulties involved in making this cross was given in these words:

"If anyone thinks he can take right hold and produce Nicotunias as he would hybrid petunias or crossbred primroses, let him try; there is no patent on their manufacture; but if the five hundredth crossing succeeds, or even the five thousandth, under the best conditions obtainable, he will surely be very successful; I do not fear any immediate competition."

It was stated that the flowers of the new hybrid are handsome, white, pink, carmine, or striped, and are borne in bounteous profusion, but that no seed is ever produced, although the plants are very readily multiplied by cuttings.

Mr. Burbank's House as Viewed From Across The Street

This view was taken from a spot close beside the greenhouse shown in a number of the earlier pictures. The foreground, therefore, shows a portion of the famous experiment garden. The old homestead, where Mr. Burbank lived for many years, is just beyond the bounds of the picture at the left, directly opposite Mr. Burbank's new home which, as will be seen, stands on a plot of ground across the street.

(14) Hybrid Nicotianas. These are hybrids produced by crossing six or more different species of Nicotiana. "Many of the new hybrid varieties are only obtained after several thousand crossings, under all conditions which seemed to promise success; but now I have perennial varieties with glaucous green foliage, edged and mottled with white, bearing pink blossoms in cymes two or three feet across with from five hundred to two thousand or more blossoms in each cyme. Most of these hybrids are readily propagated from root cuttings or slips; none of them ever bear any seed; all are unusually hardy."

(15) Begonia-Leaved Squash. "A mammoth squash which produced abundant crops for stock feeding and has bright golden variegated leaves. The unusual leaf variegation appeared four years ago [1889] on a single vine, and by selection has become so fixed that at least 95 per cent. are variegated. The form, size, and uniform appearance of the squashes has also been very greatly improved."

(16) New Potatoes. Two varieties are described as being the best of several thousand seedlings that have been tested for five years. One is a long, nearly cylindrical, smooth, white seedling of the Burbank; the other is a short, flatish, oval, light colored potato with a russet coat, from a cross between the old "Chile" or "Bodega red"

Mr. Burbank and Dr. Hugo de Vries

This picture was taken in Mr. Burbank's garden, on one of the occasions when the famous Amsterdam botanist visited Santa Rosa. Dr. de Vries has written several highly appreciative articles concerning Mr. Burbank's work; and a large part of one of his recent volumes on plant breeding is devoted to the work of the Santa Rosa experimenter.

and the Burbank. "Both are superior keepers, and have never shown any tendency to become diseased."

(17) Ornamental Crossbred Tomato. This new fruiting plant is named Combination and is described as a cross between the "Little Currant" and the "Dwarf Champion" tomatoes. "The curious plaited, twisted and blistered, but handsome leaves, sturdily compact growth, and clusters of fruit, will make it a favored ornamental plant which can be easily grown by everybody."

(18) "Other New Plants." A miscellaneous list of hybrids, including some very extraordinary combinations, particularly crosses between the different orchard fruits, peaches, almonds, plums, quinces, and apples in various combinations. The photograph of a stem of apetalous pistillate blossoms of a plum-apricot hybrid is given; a picture that has peculiar interest now in view of the subsequent development of the plumcot. Mention is also made of the crossbred tigridias, new cannas, arums, amaryllis, brodiaeas, aquilegias, and asters, and a multitude of other things not yet near enough to perfection to merit a special description. These were to appear in later catalogs.

A Summary of Conclusions

The list of "New Creations" thus briefly summarized occupies fifty pages.

There follows a concluding section under the heading "Facts and Possibilities" that summarizes the work and that may be worth quoting here for its historical interest. The wider bearings of the problems touched on will be more comprehensively discussed in a later chapter. But the general attitude of the experimenter toward his work in both its theoretical and its practical bearings is rather clearly outlined in the summary concluding a catalog which so high an authority as Professor Hugo de Vries has seen fit to describe as of epoch-making character:

"There is no possible room for doubt that every form of plant life existing on the earth is now being and has always been modified, more or less, by its surroundings, and often rapidly and permanently changed, never to return to the same form.

"When man takes advantage of these facts, and changes all the conditions, giving abundance of room for expansion and growth, extra cultivation and a superabundance of the various chemical elements in the most assimilable form, with abundance of light and heat, great changes sooner or later occur according to the susceptibility of the subject; and when, added to all these combined governing forces, we employ the other potent forces of combination and selection of the best

Gathering Poppies

The selected varieties of hybrid oriental poppies blossom early and late at Sebastopol. This picture was taken in March, 1914, not long after Mr. Burbank's sixty-fifth birthday. It is an excellent portrait of the plant developer as he is today.

combinations, the power to improve our useful and ornamental plants is limitless."

Ten Years of Progress

In describing my work, Professor de Vries has said that my catalog of 1893, the contents of which have just been summarized, gained for its author "a world wide reputation and brought him into connection with almost all of the larger horticultural firms on the earth."

It would be superfluous to recapitulate in detail the plant developments that have occupied attention at Santa Rosa and Sebastopol in the more recent years.

In the course of the decade following the announcements in the first edition of *New Creations*, the new experimental work was subjected to scrutiny by large numbers of visitors, including distinguished pomologists and horticulturists and botanists from all over the world. The new fruits and flowers had been subjected to tests sufficient to establish their merit. All skepticism as to the validity of the announcements that came officially from Santa Rosa had long since vanished.

On the other hand, there were many discriminating and appreciative notices of the new work published in magazines and books.

If I were to summarize in a sentence or two the main lines of progress of the most recent decade,

Santa Clara County
Free Li...
San Jose, ...

I should of necessity give first place to the work of development of the races of Spineless Cactus, which reached a commercial stage in 1904. The work with the Indian Corn, including, incidentally, the development of the Rainbow Corn; the development of the giant Amaryllis; the perfection of new races of Shasta Daisies; the development of new Roses, Gladioli, and some scores of other flowers; varied work with the Poppies; the development of new races of Giant Crimson winter rhubarb; the production of the Sunberry; new Plums, Prunes, Cherries, Peaches, Apples, and Plumcots; and an elaborate series of experiments with Cereals and Grasses—these represent a few main lines of the work that has occupied attention in recent years, and will serve to suggest the further lines of action that will claim attention in the years to come.

Meantime the present publication, giving the first complete and authoritative account of my work that has ever been attempted, comes forty years after the development of the Burbank potato, which marked the beginning of my plant development. Yet I have reason to hope that there are years ahead that will prove even more productive than any years of the past—perhaps in their ultimate importance more productive than all the forty years of past effort.

Luther Burbank—The Sum of His Work With Plant Life

What It Has Meant to Science and Agriculture

WE have seen that the first edition of *New Creations in Fruits and Flowers* was published in June, 1893. Perhaps we can best give an idea of the impression created by the work by quoting a few paragraphs from the introduction to the supplementary brochure that was published the following year. Although this second work was issued independently, it consisted in the main of a fuller account of some of the plant developments referred to in the first work, together with a large number of photographic illustrations. The two brochures, issued respectively in 1893 and 1894, may be considered as constituting the first official publication of the main outlines of the work in plant development which had begun in Massachusetts fully twenty-five years earlier, and which had occupied Mr. Burbank's attention unreservedly since 1885.

The impression created by the first brochure is referred to in the introduction to the supplementary one in the following words:

"Twelve months have passed since the first number of *New Creations in Fruits and Flowers* was sent out on its mission among dealers in trees and plants, great care being taken to confine it to the trade only; but before the few hundred first published were all delivered, orders came pouring in with each mail, like the falling of autumn leaves, for more, more; and again more had to be printed, and to this day the requests for *New Creations* are increasing rapidly, instead of diminishing, as it had been hoped they would.

"Probably no horticultural publication ever created more profound surprise or received a more hearty welcome. Almost every mail brings requests for them from colleges, experiment stations, libraries, students, and scientific societies in Europe and America, and it has been translated into other languages for foreign lands, even where it would seem that scientific Horticulture was hardly recognized; some asking for one, others for two or three, or a dozen or two, or more. All these requests have been cheerfully responded to, but from this time on we shall be obliged to make a charge. We cannot attend to the ever increasing avalanche of letters which they occasion, a

Mr. Burbank with a Gigantic Crinum Bulb

This also is a very recent portrait of Mr. Burbank, taken at Sebastopol. He is standing beside the trunk of the weeping birch, with which we have already made acquaintance in other pictures. The remarkable bulb is a cross between the crinum and the amaryllis, fully described in an earlier volume.

large portion of which are from amateurs, with long lists of questions, which would require years, perhaps a lifetime, to answer.

"Five years ago we sold out a nursery business which had been built up from nothing, and which was paying us fully ten thousand dollars a year, that we might give all our time and thought to the work of producing new fruits and flowers.

"Do not think because they are raised in sunny California that they are less likely to prove generally hardy. Are those already before the public any less hardy or any less valuable than most of the Russian fruits which have been so extensively advertised for years? Are not the various Plums, Walnuts, Chestnuts, etc., which have been distributed from our establishment, proving to be *hardier* even than most of the Russian fruits, and more valuable in all other respects? But the *best* ones are yet to *come*.

"About twelve years ago, when, having by thorough test found them good, we first commenced to introduce these fruits and nuts, sending circulars to most of the nurserymen in the United States, it was like trying to swim up stream in a rapidly flowing river, as very few had faith enough in them to invest in a tree; but those who were enterprising enough to do so, now find themselves fully prepared to supply the great and ever increasing

demand which has followed, and are reaping rich rewards for the small investment of enterprise and coin which they then made."

It will appear from this quotation that the announcement of the new fruits and flowers created an altogether exceptional interest, and that this interest was not confined to any one class of people. Although the announcement had been made for the benefit of practical horticulturists and nurserymen, the brochure found its way into the hands of the general public and of theoretical biologists, as well, and it would be hard to say which class of people were most exercised over it.

If we briefly review the causes that underlay this widespread interest, and, considering one class of the public after another, attempt to explain just what its attitude was toward the new work, we shall at the same time be able to present an outline of the work itself and interpret it in the light of the mental environment of the time at which the work appeared with reference to the broad problems of heredity.

Let us then attempt a brief analysis of the attitude of (1) horticulturists in general, (2) the public at large, (3) scientific biologists, and (4) working experimenters in heredity, with reference to the revelations made in *New Creations in Fruits and Flowers.* In so doing we shall gain an inkling

意を決して工場を去ることにした。

彼れは工場を去つてソースターの附近で、甚だ不規則な苗作りを始めた、之れ彼れの歴史に特筆大書すべき事で甚だ微々たるものであつたけれども、彼の將來に大關係の有する所であつた。苗木屋を初めてから間もなく、或一日ポテトーのグリンタップが不規則なる成長をなして居ること、其或部分には小さな子實を持つことに氣が付いた、此の特性に就て學術的なる研究をして居つた、彼は此シードボールを七年間も他の異つた植物を交雜せしめたならば、必ずや新奇なる植物が出來るであらうと思ふて、此シードボールの生育の狀態に注意を拂つた 今日世上に持てはやさるバーバンクポテトーは、此シードボールを土臺として進化育成せられたものであつて、之れが抑もバーバンクが植物界、農學界に貢獻した最初の發明である、此シードボールから發明せられたるポテトーは其品質の良好なる點に於て品質退化の爲めに早晩ポテトーの種絶か來るべしとの悲觀說を事實に於て辨駁したのみならず、米合衆國丈けにツ サても二千万弗位の富を一增加したのである、然れども貧困なるバーバンクは此個ポテトーを百五十弗で賣拂つて了(氏つた。

四 加州に移住

▲新開土に於ける生活難

此後數年もなくバーバンクは、七月の炎熱の爲めに日射病に罹り、永く病床に惱まされたが、病氣は恢復しても健康を甚だしく害した、然れども貧なる彼は勞働を中止する譯には行かぬ、ろこで戸外の生活をなして病氣の再

Mr. Burbank in an Oriental Setting

The photograph reproduces part of an article in Chinese, describing Mr. Burbank and his work. Some of the productions of the Santa Rosa plant developer are listed in Chinese and Japanese seed catalogs. Mr. Burbank received many useful plants from the Orient, and it is appropriate that improved descendants of these plants should be sent back to the home of their ancestors.

of the bearing of the work done at Santa Rosa on questions of practical horticulture, of public opinion, and of biological theory.

It may be added that the word "heredity" had not at this time been introduced.

Why The Orchardists Were Interested

The supplementary announcement, issued in 1894, gave the names of several important firms of dealers in horticultural supplies, who had purchased the principal new varieties announced in the brochure of the preceding year. The list included the names of prominent nurserymen from California to New England.

The interest thus evidenced by the practical orchardists and nurserymen, who measured the value of the new products in terms of dollars and cents may readily enough be accounted for. Up-to-date dealers are always on the lookout for novelties; and the fruits and flowers produced at Santa Rosa were novelties in the most comprehensive and exacting sense of the word.

They were not merely new varieties that differed by a shade from old varieties. They were new forms produced by the combination of different species, often of species brought together from different hemispheres; and they were so radically different from the forms previously in existence that many of them would, without hesita-

tion be pronounced new species by any competent botanist were they discovered in the wild state, or were their precise manner of origin unknown.

But mere novelty by no means fully explained the interest of the orchardist in the new products. In addition to novelty the hybrid fruits and flowers had qualities of excellence that gave them instant appeal.

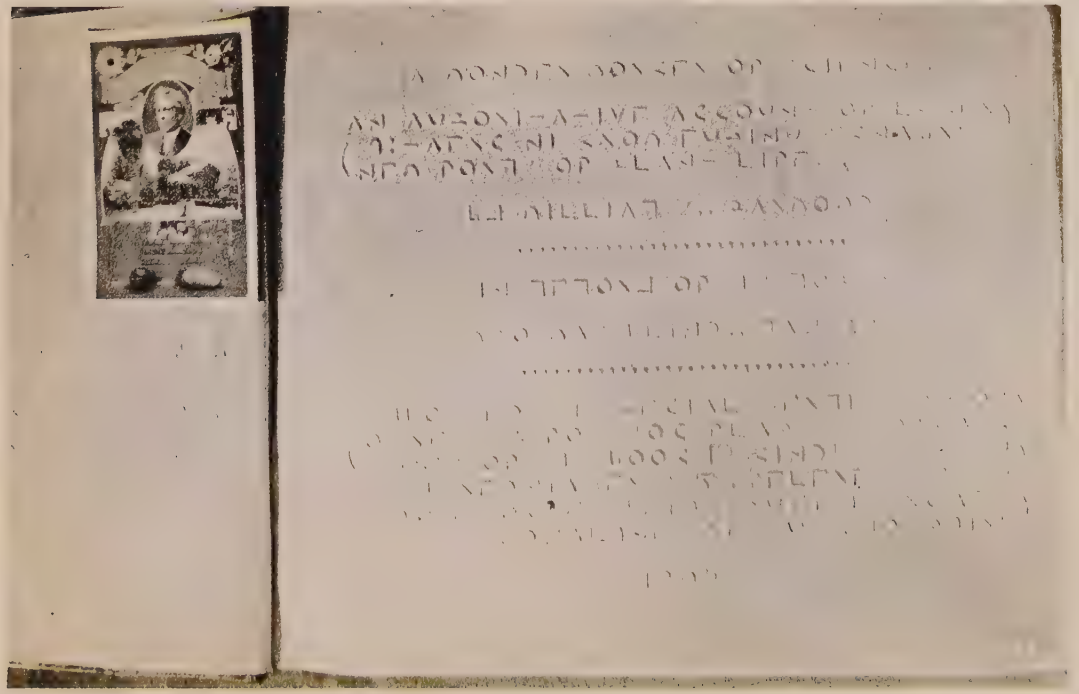
The resources of the now familiar method of half-tone illustration, at that time quite new, had been utilized to show the exact appearance of the new fruits and flowers, and so far as possible the reproductions were made of exact life size, in a good many cases one or both of the parent forms being reproduced beside their hybrid offspring, to point the contrast.

It required but a glance at the pictures of the new hybrid prunes and plums, blackberries and raspberries, roses and gladioli, nicotianas and tomatoes, to convince the skeptical that these were products calculated to appeal to the most practical growers.

The full force of this will be evident if we recall that this first announcement pictured and described such fruits as the hybrid prune that was afterward named the Splendor; the hybrid plum named Perfection, afterward famous as the Wickson; the dewberry-raspberry hybrid known every-

A Burbank Book For the Blind

This is the introductory page of a book for the blind, dealing with Mr. Burbank's methods. It is the transcription of a book written by Mr. Burbank himself, and dealing chiefly with the application of his methods to the improvement of the human plant.



where in later years as the Primus; the offspring of the dewberry and Cuthbert raspberry now known as the Phenomenal; the raspberry hybrid called October Giant and the blackberry hybrid known as Paradox; a seedling rose of exquisite quality; and the profuse-bearing double Gladiolus. Interest was further enhanced by the picturing of the hybrid walnuts, the outlines of mammoth new quinces, curiously diversified stalks of hybrid raspberries and blackberries, leaves and stems of the raspberry-strawberry hybrid, and the curiously deformed products of the engrafted potato and tomato vines.

The supplementary brochure of 1894 added striking photographic reproductions of the new white blackberry named Iceberg, a number of hybrid liles, the new and beautiful clematis flowers, the miniature calla Snowflake, branches of the new hybrid Wax Myrtles, a score or so of curiously varying fruits of the Japanese quince, and the new rose Peachblow.

There were also pictures showing the curious and spectacular diversity among leaves of the hybrid blackberries that could not fail to excite the attention of the least observant.

The contrast between the broad solid leaf of one plant, and the fimbriated fern-like foliage of another; the observation that some leaves were

arranged in groups of three and others in groups of five—these were matters that caught the eye even of the amateur, and, as a matter of course, excited the interest of the professional student of plants.

Equally striking were the full page reproductions of photographs showing various stems of the hybrid raspberries and blackberries, some of them slender and frail, others coarse and rugged; some almost thornless, and others bristling with spicules or studded with threatening spikes. The diversity of color among these stalks was clearly suggested by the half-tones, and the legend beneath one of them stated that "the colors vary from snow white, through lemon yellow, orange, scarlet, crimson, purple, light and dark blue and brown to black."

That such diversities of leaf and stem could be brought about by hybridization was a fact that could scarcely fail to command the attention of the practical orchardist, and to raise questions in his mind as to whether there were any limits to the possibilities of the new method of plant development.

At all events, it was obvious enough that, quite aside from the interesting questions suggested by the hybrid leaves and vines, here were numerous new varieties of fruits and flowers—more than fifty of them specifically named or numbered—having

A Burbank Product Highly Honored

This diploma was issued by the Lewis & Clark Exposition to a grower of the Burbank crimson winter rhubarb. It is one of a large collection of awards which have been made to growers of Mr. Burbank's products.

qualities that patrons of the orchardist might be expected to appreciate—fruits and flowers calculated to enter into competition on something more than equality with those already on the market.

Hence, no second call was necessary to challenge the attention of the orchardist, and no second announcement was required for a large proportion of the newly developed hybrids.

In a word, the practical orchardists called for the new hybrid fruits and flowers at once, and paid the prices asked for them because of the obvious practicality of the new products themselves.

Their confidence has been justified by the sequel, for great communities have been built up —as in the case of Vacaville, California, one of the great shipping centers—by these fruits, and whole communities benefited, and the occupations of the entire population changed.

The Public Interest Explained

To understand why the general public became so much exercised over the announcement of the new hybrids, it is necessary to recall that the broad general questions of evolution were still exercising the public mind at the time when *New Creations* appeared.

Darwin's epoch-making work had indeed appeared more than thirty years before, and the doc-

trine of evolution had taken its place as an accepted working hypothesis among men of science, but so revolutionary a doctrine could not be expected to make its way with the general public in less than a generation, and it is probable that, if we could accurately gauge what might be called the intellectual atmosphere, we should find that it was as fully charged in the year 1893 with doubts as to the truth of the Darwinian doctrine as it had been thirty years earlier.

At the earlier period, indeed, the man in the street had known but little of the character and implications of the doctrines involved. He perhaps had heard that "Darwin thinks men descended from monkeys", and with a few of the conventional and obvious jokes associated with that idea, the matter, so far as he was concerned, for the most part ended.

But by the closing decade of the nineteenth century, after the bitter controversies of the men of science and the theologist had been fought out, a fuller recognition of the true implications of the doctrine of evolution began to permeate the lower strata of mental life of the generation, and thoughtful minds everywhere were eagerly questioning as to what might be the full truth and the final status of the evolutionary doctrine.

Into this atmosphere of inquiry and doubt and

A Burbank Medal

This is one of several hundred medals received by Mr. Burbank in the course of the last thirty years for his almost numberless plant developments. Few men care less than Mr. Burbank for such distinctions, yet as giving official recognition to his work they are not without significance.

solicitude came the document from Santa Rosa, ostensibly only a nursery catalog, but conveying a message that made itself heard far beyond the province of the nurseryman.

Here were presented brief descriptions and photographic illustrations of a large number of new forms of plant life. These new forms were in many cases so strikingly different from the old ones that the least informed man in the street could not fail to note their diversity. Some of them obviously differed as strikingly from their parent forms, to all casual inspection, as recognized species hitherto familiar differed from one another.

In a word, here were illustrations of what appeared to be new *species* of plants, and these apparently new species were of known origin. They had been developed under the hand of the experimenter through the hybridization of old species, followed by *artificial selection* of a character having obvious affinity with the operation of *natural selection* on plants in the state of nature.

Otherwise stated, the Santa Rosa catalog appeared to tell of the creation of new species, by artificial selection, in an experiment garden, in a brief term of years.

All details aside, the photographic pictures showed offspring that seemed to be conspicuously

unlike their parents—not different enough, to be sure, to belie utterly the familiar doctrine that "like begets like", yet different enough to demonstrate, seemingly, that a new species may arise from the loins, so to speak, of the old ones.

However vaguely the laws or principles of heredity involved might be understood; however far from understanding the precise method of production of the new forms the general public might be, the tangible fact that widely divergent forms of plant life might spring from the same source—witness, for example, the brier stems of strikingly different forms or the cluster of utterly different leaves grown from the seed of one plant—was made clear beyond misunderstanding.

And this constituted, in the minds of many laymen, a clearer and more cogent argument for the truth of the doctrine of evolution than could have been found in any amount of theorizing or in the presentation of any number of illustrations drawn from the records of fossil forms or the theoretical reconstruction of the genealogies of species of past eras.

The arguments of the paleontologist and the embryologist; even the arguments of the theoretical botanist and biologist—these lay mostly beyond the ken of the man in the street. But he could readily enough understand the simple de-

Another Burbank Medal

This is a medal given to Mr. Burbank in 1910, as "complimentary award for new creations." This medal and the one previously shown were given by pomological associations. It will be seen presently that other medals have been given Mr. Burbank for plant development of quite different character,—as might be expected.

scriptions given in *New Creations.* With his own eyes he could see the striking and even spectacular differences between the plants of the same fraternity therein depicted. In effect, he received an object lesson in plant variation and a convincing argument for the truth—the tangible, demonstrable truth—of the doctrine of evolution which to him had hitherto seemed an academic question, involving the living forms of the remote geological eras rather than the forms of plant and animal life that are all about him in the world of to-day.

And this, it may be supposed, sufficiently explains and interprets the interest in *New Creations* that was manifested by that great body of intelligent laymen personified under the title of "the man in the street."

The Interest of Theoretical Evolutionists and Botanists

To understand the interest of a smaller but highly important coterie of people who may be broadly classified as students of evolution—including college professors on one hand and a few practical breeders of plants and animals on the other—we must consider yet another aspect of the intellectual atmosphere of the closing decade of the nineteenth century.

We must understand that in this period, whereas the general doctrine of evolution had

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been accepted, there was wide diversity of opinion as to many of its important details. It could scarcely be said that there was any prevalent doctrine as to what forces in nature caused the observed variation between wild forms of plant and animal life upon which the operation of natural selection is based.

The "survival of the fittest" was an accepted doctrine, but the *origin* of the fittest was an unsolved enigma.

A suggestion that new forms might arise by hybridizing existing species had occurred, doubtless, to many minds. But this idea was combated or annulled by the prevalent notion that the offspring of true species are necessarily infertile.

It is true that a few plant breeders, notably Dean Herbert and Andrew Knight, had advocated the idea that hybrids between true species may be fertile, and, indeed, had even seemed to demonstrate the truth of this view some three generations earlier. But the influence of the celebrated experimenter, Carl Friedrich von Gaertner, had served to give vogue to the opposite opinion.

Darwin had argued for the fertility of some natural hybrids, but he had not been able to make out a case that by any means carried conviction to the generality of biologists and botanists; and the current opinion was that the comparatively

A Medal from the California Academy of Sciences

This is one of Mr. Burbank's most highly prized medals. It was given in recognition of the scientific aspects of the plant developer's achievements. Not very often is it given to a man to do work that is equally applauded by commercial societies and by scientific associations.

few cases of the fertility of seeming hybrids might best be explained either on the supposition that the observed forms were not really of the parentage ascribed to them; or else that the parent forms, even though classified as different, were not really entitled to rank as independent species.

In a word, the doctrine of Kölreuter and his followers, which would make the sterility of the hybrid offspring a test of the specific diversity of the parent forms, was perhaps the stock doctrine of the biological world.

The implications of such an argument are obvious. If we are to answer the question, "What is the test as to whether two forms are entitled to recognition as different species?" by saying, "They are different if their hybrid offspring are sterile, and they are only varieties if their offspring are fertile"—we should obviously supply a definition that takes the matter beyond the range of argument.

And, inasmuch as the minds of the biologists were now adjusted to the new Darwinian idea that there is a wide range of variation in natural forms, and that natural species are after all only varieties that have separated a little farther, the idea that the classifier might be mistaken in ascribing specific difference to any pair of forms, and that the physiological test of the production of sterile

hybrids might afford a final guide, was not without its practical value, and made perhaps not unnatural appeal to the more or less befuddled classifiers themselves.

And so long as cross-fertilization was effected solely between forms of animal or plant life that were found growing wild in the same region, and were obviously not very distantly related, it was hardly possible to present evidence of the fertility of hybrids between true species that would be convincing.

The more fully the biologist grasped the philosophical idea that the word "species" is after all only a convenient formula to apply to a given form rather for convenience of nomenclature than as representing true and permanent distinctions, the more logically might he grasp the dictum that any two forms that can interbreed and produce fertile offspring are not entitled to rank as species, even in the modified view of the meaning of the word species that the evolutionary doctrine has introduced.

Yet after all there is a certain tangibility about the idea connoted by the word species that the practical classifier cannot ignore. The blackberry and the raspberry, for example, are so obviously different in many really essential parts of their structure that to deny them specific individuality

A Gold Medal From the Pan-American Exposition

This was a special award made to Mr. Burbank in 1901 in recognition of his development of the wonderful new fruit called the plumcot. As was remarked at the time, the Exposition could not well have offered a prize for such an exhibit, inasmuch as no such hybrid fruit was known, or its production anticipated. But the authorities judged the strange new fruit worthy of their highest award none the less.

would be to introduce an element of iconoclasm that would shake the entire structure of systematic botany.

So when evidence is presented that a blackberry and a raspberry have been hybridized, and that the offspring is a plant quite as fertile as either of its parents, though markedly different from both, the case seems to give evidence that the offspring of true species are not necessarily sterile.

And the fact that the new hybrid differs so widely from either parent that it would be named by the classifier as constituting a new species according to ordinary standards, and that it breeds true to its new form, seems to furnish further evidence that new species of plant life may conceivably arise by the hybridization of old species.

In a word, a single case like that of the hybrid Blackberry-raspberry, described and depicted in *New Creations* under the name of the Primus Berry, would seem by itself fairly to establish the doctrine that new species of plants may arise by the hybridization of old species.

Stated otherwise, the case of the Primus berry would seem to furnish unequivocal evidence as to at least one way in which the problem of the origin of new species might be answered. The *survival* of the fittest had been explained as an essential part of the Darwinian doctrine. The

origin of the fittest (or at least one possible origin) appeared to be explained by the existence of such a hybrid as the Primus Berry.

The parents of the Primus berry, it will be recalled, were the California dewberry (*Rubus ursinus*) and the Siberian raspberry (*Rubus crataegifolius*). Not only are these forms so different in appearance that no botanist would ever think of denying that they belong to totally different species, but the fact that one of them is indigenous to California and the other to Siberia gives what might be called geographical support to the opinions of the classifiers. Few indeed are the forms of animal or plant life inhabiting the Eastern and the Western Hemispheres that are recognized as specifically identical.

The same genera are represented on both continents, because the remote progenitors of all races of animals and plants of the Northern Hemisphere were once inhabitants of a common territory in the region of the North Pole. But there has been no opportunity for the mingling of Asiatic and American forms of plant life since the separation of the continents, until civilized man in very recent time began to transport forms of animal and plant life across the oceans.

There had been no communication since a remote geological era—probably not since the last

A Medal From the California State Agricultural Society

This medal which, as will be seen, bears the great seal of the state of California, was awarded in 1907 in honor of Mr. Burbank's achievement in producing the spineless cactus. Of all Mr. Burbank's medals, none was perhaps better earned than this. Certainly no other was more laboriously earned. It is pleasant to relate that the spineless cactus has brought Mr. Burbank unusual monetary returns in addition to such honors as that signalized by this medal.

ice age; so on mere geographical grounds the specific difference between the Siberian raspberry and the California dewberry might be accepted without further argument. But, quite aside from this, differences between the two forms are sufficient to give them independent specific rank in the mind of any botanist.

The fact that one is classified as a blackberry and the other as a raspberry will sufficiently establish their diversity in the mind of the layman.

Yet the report from Santa Rosa told of the hybridizing of these diverse forms, and of the production of a new fruit differing very markedly from either parent, although retaining some of the characteristics of each; and told further that this new hybrid, far from being sterile, has such fertility that it ripens its main crop of berries long before most kinds of raspberries and blackberries commence to *bloom,* and continues to bear more or less berries all summer.

So the evidence that hybrid offspring of two species may be fertile and may thus offer material for the action of natural selection in the creation of new species appeared doubly demonstrative.

It is probable, then, that the announcement of the development of the Primus Berry would have aroused no small measure of interest among practical plant breeders and theoretical students of

evolution, even had it been made by itself as a single and isolated experiment in hybridization.

But, in point of fact, the record of the Primus Berry was accompanied by similar records of an entire company of new hybrid blackberries and raspberries. In the same section of *New Creations* that told of the Primus Berry, there was the record of an equally remarkable blackberry-raspberry hybrid of an entirely different character, the parents this time being the California dewberry and the well-known Cuthbert raspberry, the latter a native of England.

Three hybrids of this cross were offered for introduction, one of them being the extraordinary berry that was afterward named the Humboldt, and then renamed the Phenomenal.

There were two other hybrid dewberries of only lesser interest. There was also the hybrid between the Crystal White Blackberry and Shaffer's Colossal Raspberry, which produced the berry famous afterward as the Paradox, and from which new races of raspberries and blackberries of almost every conceivable combination can be produced, as the photograph showing varied leaves, to which reference has already been made, amply demonstrated.

Then, too, there was the hybrid between the Japanese Golden Mayberry and the Cuthbert

A Medal From the California State Floral Society

Mr. Burbank received this medal, as will be seen, in recognition of the merits of one of his seedling climbing roses. Another gold medal that Mr. Burbank highly prizes is the one received at the International Exposition at St. Louis for the "best bedding rose." These instances, with many others that might be cited, show that Mr. Burbank's success as a plant developer extends to the commonest garden products as well as to the rarest.

Raspberry; and there were no fewer than ten other raspberry hybrids that were listed specifically each under a definitive name or number, and offered for sale as new varieties at a specified price.

Moreover, a list was given of no fewer than thirty-seven named species of *Rubus* (the generic name of the tribe of raspberries and blackberries) that had been utilized in the hybridizing experiments through which the new varieties have been produced; and the statement was made with reference to the list that "the combinations are endless; the results are startling and as surprising to myself as they will be to others when known."

An inkling of the work involved in the production of these unique results is given in an explanatory paragraph:

"Everybody appreciates delicious berries, but probably not one person in each million has the faintest idea of the labor and expense of crossing, raising and testing *a million new kinds of berries* as the writer has done, and selecting with untiring diligence those which are to become standards of excellence as the years roll by.

The reader of earlier chapters of this work will fully comprehend the sense in which the phrase "a million new kinds of berries" is used. We have learned that each variant type of cultivated

fruit is regarded by the orchardist as an independent variety, owing to the fact that it may be propagated indefinitely by division or by grafting.

"A million new kinds" refers to the endless diversity of individual forms among hybrid blackberries and raspberries, from among which a score or so had been selected as worthy of introduction. It should be added, however, that certain of these, including the Primus berry and the Phenomenal, were fixed varieties or new species that would breed true from the seed.

In another clause reference is made to "fourteen years" of experiment, revealing the fact that the blackberries and raspberries were among the plants that Mr. Burbank had found time to experiment with extensively during the ten year period of the nursery experience that preceded the establishment of his experiment gardens.

It was partly because these fruits had been experimented with for this long period that so large a section of *New Creations* was devoted to new races of hybrid berries.

It should not be understood, however, that the work with the blackberries and raspberries stood at all by itself in presenting evidence of the fertility of hybrids, and in thus throwing new light on the problems of evolution.

On the contrary, evidence of precisely the same

A Burbank Prune Orchard

This picture shows part of a sixty-acre orchard of Burbank prunes. The return from this orchard has been as high as seventy thousand dollars a year. The orchard itself does not belong to Mr. Burbank who, as the reader is aware, does not raise fruit for the market, but the fruit raised in the orchard is the product of his ingenuity and industry.

character was presented by one after another of the different records that made up the total of more than fifty new hybrid varieties of nuts and orchard fruits and flowers offered for introduction in the pages of *New Creations*.

The hybrid walnut, known as the Royal, one parent of which was the black walnut of the East and the other the black walnut of California, was represented by its gigantic nut, depicted on the same page with the smaller nuts of the ancestral forms. And it was particularly noted that the new hybrid had borne nuts in abundance, although the other hybrid walnut, due to the union of the California and Persian walnut, had not then borne fruit.

It may be added that the relative infertility of hybrids between forms distantly related is recognized in the course of the description of this second hybrid walnut, in the statement that in its failure to bear fruit it is like many true hybrids; the writer having doubtless in mind such examples as those furnished by the new plant called the Nicotunia, a combination of the tobacco and the petunia, which is described on another page of *New Creations;* and the equally interesting hybrid between the raspberry and the strawberry, also described and depicted.

These sterile hybrids, with which the reader

of the present work is already familiar, illustrate another aspect of heredity no less interesting; but at the moment we are concerned with the fertile hybrids.

And these, it may be added, include all the fifty-odd plants described in the catalog, with the three exceptions just noted.

Without entering into specific details, we may briefly note that the new hybrid plums here listed, and for the most part pictorially shown, were ten in number, involving the racial strains of species from Japan and China, from Europe, and from various regions of America.

The hybrids among flowers were also given full representation, ten pages of the catalog being devoted to them, and the new varieties named and described including roses, callas, lilies, gladioli, a number of forms of clematis, and a new poppy. New types of hybrid seedling potatoes were also listed, and a new form of crossbred tomato, called the Combination.

The extraordinary Aerial potatoes grown on potato vines grafted on the roots of the tomato; and the no less extraordinary potatoes grown on a stock having an engrafted tomato top are also shown, although merely as curiosities and not as commercial products.

To complete the summary of the evidence that

A Burbank Cherry Orchard

This is another highly remunerative orchard in which Burbank products are grown on a commercial scale by a practical fruit-marketer. There are numberless such orchards, growing one or another of the Burbank improved fruits, not only in California but in practically every fruit-growing region of the temperate zone.

was presented for the possibility of producing new varieties through hybridizing old species, it should be added that mention was made in a separate section of numerous experiments with seedlings of the ampelopsis, a new type of wax myrtle, and "some charming, crossbred seedling tigridias, new cannas, arums, amaryllis, brodiaeas, aquiligias, asters, and a multitude of other things not yet near enough to perfection to merit a special description; yet some of the hybrids of which are worthy of much study." A list of other species that had been mutually hybridized begins with the peach and almond, and names more than twenty crosses between the various types of orchard fruits—apricot, plum, quince, and apple, as well as peach—in various combinations.

Without detailing further examples, it may be said that this body of evidence was overwhelming. It could be supplemented indefinitely, of course, by examples from other plants in my experiment gardens. But without further elaboration, the examples cited in my first two catalogs sufficiently establish the fertility of hybrids of many species of widely different families.

Thenceforth there could never be any doubt in the minds of practical plant developers that true species, within certain limits of affinity, may be interbred and produce fertile offspring.

On the other hand, the examples of the strawberry-raspberry, and the petunia-tobacco might be cited in proof that species too widely removed from each other produce sterile hybrids.

Thus the experiments as a whole show on one hand the method through which material is supplied for the operation of natural selection; while, on the other hand, they show how barriers are ultimately erected that prevent crossbreeding from being carried to an extent that would introduce a chaotic element in the scheme of evolution.

The importance of such a demonstration as this, made for the first time on a really comprehensive scale in the experiment gardens at Santa Rosa and Sebastopol, soon came to be generally recognized.

The New Experiments and Mendelism

Perhaps it may be of interest, in extension of the present theme, briefly to trace the relation of the new experiments to the particular aspect of the theory of heredity that has most actively claimed the attention of the biological world in very recent years.

He refers, of course, to the doctrine of Mendelism, which was to take the biological world by storm in the first decade of the twentieth century.

Of course the results of the hybridizing experiments performed in my experimental gardens and

A Paying Burbank Potato Patch

Few vegetables give a more certain and better paying crop, year in and year out, than the potato; and few other potatoes equal the Burbank in their regularity and abundance of yield of vegetables of the highest grade. There are regions of the Pacific states, in particular, where thousands of acres are given over to the growing of the Burbank potato exclusively.

recorded in the catalog of 1893 could not be at once interpreted in what are now spoken of as Mendelian terms, because at that time no one knew anything of Mendelism as such. The experiments of Mendel had indeed been made just thirty years before, and Mendel himself, as it chanced, had died in the very year—namely 1884—in which my first importation of plants from the Orient, to furnish material for experiments, was made. But, as the reader is aware, the publication of Mendel was altogether ignored, and nothing was heard of his experiments until his paper was rediscovered by Professor de Vries and by two others about the year 1900.

But it is elsewhere pointed out that whereas the Mendelian formula was not then in vogue, yet the essentials of the aspect of heredity that Mendel espoused were abundantly illustrated in the hybridizing experiments, the results of which were published in *New Creations* (1893) and its successive supplements.

It is scarcely necessary to remind the reader that the essentials of the aspect of heredity in question had to do, as stated by Mendel, not so much with the great mass of heritable characters, as with some of the minor points of difference that mark varieties within a species. Mendel himself did not hybridize different species, or, if he did,

the records of such hybridizing have been lost. His essential experiments had to do with garden peas and with the manner of transmission of the minor difference between varieties of these peas—tallness versus shortness of stem, purpleness versus whiteness of flower, yellowness versus greenness of pod, and so on.

But the peculiar manner in which these antagonistic pairs of qualities are given representation in the offspring of parents having the opposite traits, is precisely duplicated when the cross-fertilization is similarly effected between allied species that show corresponding diversities.

In each case, the essential fact is that certain minor characters or groups of characters tend to assume prepotency or dominance in hybrids of the first generation; and that both the dominant and the submerged (or recessive) characters appear in the hybrids of the second generation segregated and variously recombined, so that where several pairs of qualities are under consideration, the offspring of the second generation constitute a most heterogeneous lot, in which the diversified traits of their grandparents are mixed and blended and mosaiced together in every conceivable combination.

Not only were these essential facts clearly revealed by my early hybridizing experiments,

A Paying Burbank Grape Vineyard

Mr. Burbank has developed many improved varieties of grapes, some of which are extensively grown and others of which promise to have great popularity in the future, when their merits are more fully known. This picture has double interest as showing the typical manner of cultivation of the vine in California.

but they were succinctly expressed in the text of *New Creations*, and the diversities of forms among second generation hybrids were illustrated by photographs showing many types of hybrid blackberry and raspberry canes and leaves.

The diversity of second-generation hybrids was illustrated by such other examples as the Phenomenal Berry and two other hybrids listed in the catalog under separate numbers and announced as of the same origin.

But for that matter, the segregation and recombination of characters in the second generation, leading to endless diversity or variation, was illustrated in the case of every new variety named in the entire catalog, with the exception of the Paradox and Royal Walnuts and the Primus Berry, these alone being first-generation hybrids.

Quotation has already been made as to the "million kinds" of blackberry hybrids of the second generation. It may be added that in the supplement of 1894, a photograph was reproduced that showed a "sample pile of brush twelve feet wide, fourteen feet in height, and twenty-two feet long, containing sixty-five thousand two- and three-year-old hybrid seedling berry bushes (forty thousand blackberry-raspberry hybrids and twenty-five thousand Shaffer-Gregg hybrids) all dug with their crop of ripening berries."

It was stated in connection with this picture that of the "forty thousand blackberry-raspberry hybrids of this kind, Paradox is the only one now in existence. From the other twenty-five thousand hybrids about two dozen bushes are left for further trial, but from these selected ones, wonderful new berries are appearing whose forces are so fixed in the right direction that they generally produce good and productive seedlings."

It may be of interest, as giving farther insight into the work, to quote the concluding sentence which states that: "This pile of brush cost something like $700, and is one of fourteen similar piles which were cremated on one of my places last summer."

Of similar import is the account given of the hybrid lilies, which were declared to be so varied in character, thanks to the hybridizing of many species, that "all the earth is not adorned with so many new ones as are growing at my establishment." A description of the varied characteristics of some of these lilies, and two pages of illustrations showing fifteen diversified forms, are introduced by way of substantiation.

To the reader of to-day it may seem a work of supererogation to dwell thus on the fact that experiments, the results of which were published in 1893-1894, demonstrated so obvious a proposition

An Improved Bartlett Pear Orchard

This is an orchard of Bartlett pears, improved by utilizing the Burbank methods, which is earning one thousand dollars per acre. Note the attractive and symmetrical form of the low-headed trees; also the evidences of thorough cultivation of the soil.

as that hybrids are relatively uniform in the first generation, and highly diversified in the second and a few succeeding generations. But it must be understood that this was the essential discovery that made possible a large part of my successes in producing new varieties by hybridization. And it must further be recalled that the facts in question were ardently contested by large numbers of the leading botanists and the most authoritative students of hereditary theory.

It was the demonstration made a thousand times over at the experiment gardens at Santa Rosa and Sebastopol that first showed in a comprehending and convincing way that such is the operation of the principles of heredity in determining the characteristics of hybrid generations.

And, as has elsewhere been suggested there is no doubt that it was these demonstrations that prepared some of Mr. Burbank's most eminent critics, including Professor de Vries, to accept the Mendelian statement of this proposition when it came finally to their attention.

It may be added that the subsequent history of such aspects of the problem as came to be associated with the name of Mendel has shown curious analogy with the history of the Weissmannian doctrines to which reference has been made in another connection.

Just as followers of Weissmann were obliged to shift their ground to meet the evidence brought by new experiments, until finally all that remained of their doctrine had been substantially harmonized with and blended into the broader and earlier theories of Darwinian heredity, only the doctrine of the continuity of the germ plasm remaining as a permanent acquisition; so the attempt to make "Mendelism" comprehend the entire subject of heredity, has necessitated a perpetual modification of the point of view, and an amplification of the terminology to meet the facts of more comprehensive experiments, until Mendelism has come to be harmonized with and blended in the more comprehensive knowledge of heredity, leaving only the formulae associated with dominance and recessiveness to mark the individual contribution of Mendel to the all-comprehending subject of heredity.

—Into an atmosphere of inquiry and doubt and solicitude, came the document from Santa Rosa, ostensibly only a nursery catalog, but conveying a message on heredity that made itself heard far beyond the province of the nurseryman.

A Bed of English Primroses or "Cowslips"

This bed of flowers grew last season beside Mr. Burbank's greenhouse at Santa Rosa. It shows how Mr. Burbank, even when not working for a specific end, delights in getting a number of variations before him. He inspected these flowers daily during 'heir time of blossoming, and made selections among them; and though at the time he had no very specific purpose in so doing, it is more than likely that interesting results will come of the primrose experiments before these flowers are banished to make room for some other claimants of space.

Luther Burbank—The Bearing of His Work on Human Life

—On Improving the Human Plant

STUDENTS of heredity are becoming more and more agreed that the same laws and principles apply to the organisms of the vegetable and animal worlds. This is quite what might be expected, considering the fundamental identity of protoplasm, which is the physical basis of all life. But quite aside from any theoretical deductions in the matter, a wide range of experiments with many types of animals has brought conclusive evidence that striking analogies are everywhere to be found between the manner of transmission of traits and characteristics in plants and animals.

Moreover observations of human genealogy have shown that man himself is subject to precisely the same laws of heredity that apply to the lowliest vegetable or animal organisms. We must of course make allowance for differences incident

to the elaborate organism of man, and we must not forget that man differs from the other organisms in that he can take conscious note of the conditions of his heritage and of his environment and can be guided in a measure by what he thus learns.

This fundamental fact gives man a place apart in the entire scheme of evolution. But it does not remove mankind from the limitations imposed by the laws of hereditary transmission. He can consciously modify his environment and he can be guided in his selections by his knowledge of heredity; but he cannot free himself from the thralldom of environmental influences or from the inexorable limitations of his ancestral heritage.

In some respects, indeed, man is far more hampered when he attempts to apply the laws of heredity to his own race than he is in making application of the same laws to the basis of transient animals under domestication. The necessities of the social organism that he has built up place limitations on his freedom of selection in the mating of individuals and even sharper restrictions on his selections among the progeny for the parents of future generations.

Indeed, until very recently it has not been thought fitting that man should give any consideration whatever to the scientific breeding of his own

The South American Scilla

This picture, and a few succeeding ones, are introduced as showing specimens of the plants with which Mr. Burbank's newest experiments are being performed. A large bed of the South American Scillas grew in his garden in Santa Rosa the past season, undergoing the usual careful observation and discriminating selection. The results will be known in subsequent seasons.

race, notwithstanding the obvious advantages that have resulted from the scientific breeding of races of plants and animals.

Of late, however, it has gradually dawned on the intelligent people of the world that the laws of heredity which confessedly apply to man might rationally be given consideration in the breeding of races of men. The new science of eugenics, named and in large part originated by the late Sir Francis Galton, has received an amount of attention in very recent years that it could not possibly have hoped to receive had it been brought to the attention of the public even twenty years ago. And it cannot well be doubted that the demonstrations as to the possibility of improving the races of valued plants by selective breeding made at Santa Rosa and Sebastopol have had their share in calling public attention to the possible benefits that may accrue from the systematic and intelligent application of the principles of heredity.

A general appreciation of the unity of life-forces as well as of life substances, due primarily to the spread of the Darwinian doctrine, has prepared the public to look with unbiased eyes for the first time on the human race itself as an evolution product that owes its pre-eminence to the conscious utilization of natural forces and that may obtain still greater heights by the still more

intelligent utilization of these forces. So it will be accepted as a mere matter of course that we should attempt, in completing the review of Mr. Burbank's life work with the development of new forms of plant life, to make application of the practical knowledge gained in the experiment garden to what might, without violence to words, be described as the breeding of the human plant.

Such an application we shall now attempt, concisely, yet with as much explicitness as is warranted.

The Great Principle of Selection

Even the most casual reader of this work will be aware that the great fundamental principle that guides us in all stages of our experiments in plant development is the principle of selection.

We select first the kind of plant that is to be utilized in a given series of experiments. We select the best individual or individuals to be found among the entire company of these plants at our disposal. We select other individuals of the same or of different species as mates before cross-pollenizing, and in successive generations we repeat these processes of selection and re-selection over and over.

Now in the human family precisely analogous processes of selection are being employed, consciously or unconsciously, in every community. Of

The Abutilon or Flowering Maple

These are seedlings of the Abutilon Vitifolium, the mother plant having grown for several seasons beside Mr. Burbank's old homestead at Santa Rosa. The present experiments are designed to produce improved varieties of this attractive flowering shrub.

course the selections are not usually made with the definite and avowed object of producing progeny of an improved type; but the inherent affinities that lead to the selection of marriage partners are themselves determined by principles that might properly be said to be eugenic—providing artificial restrictions do not too greatly interfere with the freedom of choice.

Generally speaking, men and women would choose marriage partners having vigor and health and beauty to the exclusion of those showing the opposite traits, were free choice given them.

But, of course, under actual social conditions, entire freedom of choice is impossible, and no fact is more distressingly patent than the fact that large numbers of persons who are obviously unfit to assume the duties of parenthood nevertheless enter the marriage state and bring forth abundant progeny.

Indeed, under existing conditions, it is the all too general observation that the notoriously unfit members of the community are the ones that produce the largest families.

Now it requires no very profound knowledge of the laws of heredity to understand that such a condition of things is not conducive to the betterment of the race. No one could hope to produce an improved variety of plants of any kind if he had not freedom of choice in determining that

the more desirable individuals should be mated and their progeny preserved to the exclusion of the progeny of the less desirable.

The entire foundation of plant improvement depends, as we have all along seen, on such freedom of choice. And in proportion as the plant developer selects wisely, chooses the individual plants that have the best hereditary tendencies, mates the right individuals, and rigidly selects the best only among their progeny, can he hope to progress in the direction of his ideal plant.

It would appear, then, that unless human society can devise a means whereby a preponderant number of the offspring of each successive generation are the progeny of those members of the community who are superior in body and mind and morals, we cannot expect that the human race will improve generation after generation.

Any colony of flowers left to breed indiscriminately, good or bad, will inevitably degenerate from the stage of culture to which artificial selection has brought it. The reason for this is that the conditions imposed by cultivation are different from the conditions of Nature and the special development of the plant has taken place along the lines of man's tastes and needs without special regard to the needs of the plant itself.

But if you remove the artificial conditions, so

The Blue Flag

A prominent horticulturist has said that Mr. Burbank cannot keep his hands off any plant that comes under his observation. His every instinct calls out to him to test the plant and see what can be done to better it. This blue flag is an illustration of a flower that is being thus tested, probably without any very specific object. Not even Mr. Burbank can tell what unexpected variations may show themselves, offering material for interesting developments.

that the conditions of Nature again prevail, then selection will take place in accordance with the needs of the plant itself, and this will imply a reversion, in the course of a few generations, to something like the original wild state of the plant.

Unnatural Standards of Civilization

Now the conditions of human civilization are no less artificial.

Standards of excellence among civilized men are quite different from the standards of excellence among barbaric races. We do not count a man as the foremost individual in his community because he has the physical ability to wield a heavier club than his neighbor can wield, nor because of the ruthless freedom with which he exercises his superior strength.

Among savage tribes mere physical strength, coupled with brute cunning and ferocity, may determine leadership. Such are the natural and necessary standards so long as man is at war with wild beasts and with other savage men that know no law except that of physical supremacy.

But under conditions of civilization all that has been changed. The standards of excellence that determine the position of men and women in any given community are mental and moral rather than merely physical.

They are in the broad sense of the word *un-*

natural standards, but they are the only standards compatible with the persistence of the *unnatural* state of society that we term civilized.

So it has come about that the condition of men in civilized society is closely comparable to the condition of plants in a hothouse or in a carefully cultivated and weeded garden. The very conditions of civilization make it as essential that the human weed should be removed and the unfit members of the community prevented from propagating their kind as that similar principles should apply in the hothouse or the flower garden.

Under the conditions of barbaric life, and even under those of the high civilization of classical antiquity, the principles of eugenic selection thus implied were carried out with a good deal of rigor. Even if the weaklings were not consciously removed—and this was sometimes done—the stress of living was such that the abnormal or weakly infants were claimed by disease, and the adults who lacked strength and intelligence were likely to succumb to the attacks of wild pests, to starvation, or to the onslaught of human enemies.

So the principle of selective or eugenic breeding was all along applied, even when no one comprehended its meaning or gave it a name; and the results are seen in the progress of humanity to its present state.

In very recent years, however, there has been great progress in the way of ameliorating the environment, in particular the environment of childhood, through improvement in the understanding of hygiene and the prevention of disease, so that there is no longer the weeding out of the unfit in infancy that occurred even a single generation ago; so the generation of to-morrow are confronted with problems of selection in the breeding of the human race more urgent than ever before.

The problem is complicated by the fact that the more intelligent members of the community—precisely the ones that should be selected for the propagation of the race—are prone to restrict the number of their offspring, whereas the less desirable parents practice no such restriction.

The obvious tendency of this must be comparable to the condition of a flower garden in which the best plants are restricted to the production of one or two seed pods while the poorer varieties are allowed to scatter their seeds by indiscriminate thousands.

The plant breeder who permitted such a condition to obtain in his garden would assuredly not produce improved races of plants.

And the human system which permits such a condition to obtain cannot hope to better the average condition of the human race.

The Parrot Bill Flower

This is a speeies of Clianthus which Mr. Burbank has under careful scrutiny, and the possibilities of which, as to variation, modification of flower, and the like, he is carefully testing. Rare flowers and common flowers are of equal interest to Mr. Burbank, as the reader is aware. In his eyes, no flower is devoid of beauty and none can justly be designated as "ordinary."

As to the precise methods through which conditions more in accordance with the improvements of the future generations of our race are to be applied, we shall attempt no details of suggestion. It suffices to point out the principle and to suggest that there cannot well be two opinions as to the desirability of restricting the fecundity of the unfit, however wide the diversity of opinion as to the way in which this may be practically accomplished.

The Aristocratic American Race

Lest we seem to take a pessimistic view of the situation, however, let me hasten to point out that the average human plant in most communities of America to-day is somewhat comparable to the average plants in the most highly developed colonies of Mr. Burbank's experiment gardens.

The reader will recall the somewhat detailed accounts that have been given of the cherry colonies comprising 400 aristocratic families, and of the various colonies of plums and quinces and chestnuts and lilies and gladioli and Watsonias and countless others that are similarly made up of individuals exclusively of good breeding and of desirable qualities.

Now, whoever will properly gauge the condition of the human garden of to-day, here in America, must realize that in general the races of

human beings that make up the population are of correspondingly aristocratic lineage.

Here of course we do not use the word "aristocratic" in the conventional sense. We are referring to the qualities that make a good and desirable citizen; and mean to imply that the process of crossing and selection has been carried out so well for the past ten generations or so in America that a race has been developed having a very high average of those traits that determine "fitness" for existence in a civilized community.

It is true that there are certain strains of abnormality—of physical degeneracy, mental obliquity, moral perversion—that have made their way, generation after generation, like weeds in the garden, and that must constantly be reckoned with just as the gardener reckons with his weeds. But the main body of citizens that make up the population are at least moderately fit to live in harmony with the normal environment of civilization, and by the same token to reproduce their kind.

Unfortunately, however, there has been a very pronounced tendency within recent decades for the individuals who were reared under the healthful conditions of the farm and village to make their way to the cities and to take up the relatively abnormal life that is forced upon a majority of the city population under existing conditions.

The Calceolaria

Another example of the almost numberless varieties of flowers that are still undergoing tests at Santa Rosa. The reader has been told that not fewer than three thousand experiments are carried forward together, and new flowers are claiming attention faster than old ones are perfected or discarded.

The offspring of these city dwellers are reared in an environment radically different from the healthful one in which their parents were reared.

They are crowded into dark, ill-ventilated tenements, amidst surroundings that not only lack the light and air and joyousness of the country, but are often positively vitiated as to their mental and moral no less than as to their physical atmosphere.

It is as if we were to take the plants that have been bred in the rich, well watered, carefully weeded soil of a garden and transplant them into an infertile, dry soil, choked with weeds and away from sunlight.

By no chance could we expect the plants under these conditions to attain full growth or to put forth even a fair complement of flowers and fruits.

The Burbank giant amaryllis bulbs, which under proper conditions will put forth splendid stalks bearing flowers ten inches across, would be reduced, under such altered conditions, to the throwing up of meager stalks and, at best, the production of a restricted number of dwarf flowers little calculated to add to the reputation of the plant developer.

The Power of Environment

This matter of environment, then, goes hand in hand with heredity and is a final determining fac-

tor in deciding the character of the individual product.

It is quite useless to have practiced the most rigid selection among plants for any number of generations, and thereby to have produced varieties of the most splendid possibilities—unless the plants of the newest generation are given proper soil and nourishment and sunshine they will come to nothing.

And so it is with the human plant. Despite the good heredity of generations of ancestors bred, let us say, from the old Pioneer stock in New England or Virginia or from the transplanted cions of that stock in the Middle or Far West, the coming generations will be dwarfed and perverted representatives of their race if they are denied a normal environment, particularly in childhood.

So one of the great problems that confronts the humanitarian of to-day is the problem of providing a proper environment for the human plant.

In the decade covered by the most recent census returns (1901-1910) the total population of the United States increased by 21 per cent.. But the rural population increased by only 14 per cent. and the city population by 38 per cent. There are entire states in which the rural population did not increase at all, and these were precisely those middle western farming districts that supply the health-

A Selected Dandelion

Mr. Burbank delights in taking common plants of all kinds and improving them through care and selection. Probably he had looked forward for many years to a time when he could find a few moments of leisure to devote to the common dandelion; and this plant is now being improved under his tutelage.

iest of all environments for the production of improved examples of the human plant.

It is not meant to imply that the environment of the city is necessarily unwholesome. But it requires no argument to show that the average city dweller is less favorably situated for the development of normal children than is the average dweller on farm or in country village.

Children vitally need fresh air and sunlight and the out-of-door life.

They need to be allowed to romp in the fields and to come in contact with nature.

The city walls and pavements are a pitifully inadequate substitute for the greensward and the trees of the country. And a generation for which this substitution has been made cannot be expected to improve upon the traditions of its parent generation.

So the student of the human plant will do well to give full attention to the question of improving the environment of the human colonies with which he is concerned.

The story has been told of the way in which the soil of my experiment garden at Santa Rosa was prepared and modified and even metamorphosed until the conditions were attained that were favorable for the growth of my plant charges. Without such attention to the physical environment it

would have been quite impossible to produce the improved races that have been developed at Santa Rosa and Sebastopol.

And unless a way can be found to make the average environment of successive generations of human beings better and better—instead of allowing it to become worse and worse—we cannot hope that the generations of our grandchildren and great grandchildren will maintain the average standards of our own time, let alone improve upon them.

Educating the Seedling

A word must be said also as to the influence of environment in its bearing on the mental and moral development of the individual in determining the bringing out or the suppression of hereditary potentialities.

The mental and moral attributes of man may be likened to the flower or fruit of the cultivated plant, in that they are the qualities most recently developed or transformed through selective breeding. In token of their newness, they are the qualities most easily altered or modified by environing influences or by new racial blendings.

There are, for example, the qualities that are prone to "Mendelize" in hereditary transmission, as we shall see illustrated and interpreted in another connection.

The Old Homestead in Autumn

This house was for many years the home of Mr. Burbank, and it still stands on his grounds at Santa Rosa, being now utilized for offices of The Luther Burbank Society.

The direct influence of environment on these highly differentiated and hence unstable characteristics of plant or of man is easily demonstrated in any experiment garden or in any social community.

But even the most deep-seated and fundamental qualities may be profoundly modified if the environing influences are applied during the childhood of the seedling plant or the human subject.

"As the twig is bent the tree is inclined" is a maxim the literal truth of which is apparent to the least-skilled horticulturist. The application of the maxim to the human sapling is equally familiar matter of fact to even the tyro in human pedagogy.

A Shakespeare is not born with a fund of knowledge and a profuse vocabulary stored in his brain; but only with the receptive quality of brain-fibre that will enable him—granted proper surroundings—to acquire knowledge of things and of words. Placed in childhood on a South Sea Island, among savages, Shakespeare could have passed his life without knowing a single word of the English tongue, and without having even the vaguest conception of the existence of a written language of any kind.

This extreme example will serve to suggest the extent to which the individual even of the very

best heredity is dependent upon environment for the bringing out of his inherent potentialities.

As another extreme example might be cited the case of the child who becomes blind and deaf in infancy through some accident or disease. Such a child will commonly remain at a stage of mental culture comparable to that of a congenital idiot. Exceptional cases like those of Laura Bridgman and Miss Helen Keller, in which, through infinite effort, the other senses are made in part to compensate for the loss of sight and hearing, building up the brain through vicarious channels, serve to give further emphasis to the fact under consideration—the all-importance of the environing influences that we commonly speak of as "educational" in completing the work which heredity carries only to the nascent state of development.

The Mixture of Races

Yet another respect in which the problems of breeding a better human race in our day run parallel to the problems of the plant developer is with reference to the foreign materials that make up the stock for the propagation of future generations.

It will be recalled that some of Mr. Burbank's most important successes were achieved by blending the racial strains of plants brought from different continents. Plants were imported from Japan,

Rear of the Old Homestead

Any house that Mr. Burbank occupied would be sure to be vine-covered and embowered in foliage. This is the rear entrance of the Old Homestead, and the one which Mr. Burbank habitually uses when he visits the rooms of The Luther Burbank Society.

from New Zealand, from Siberia, from South Africa, from Canada, from South America. Carefully selecting among them, he inbred the species from widely separated regions, and thus brought together racial strains that had long diverged.

And the results were often startling, and sometimes highly gratifying.

It is easy to draw the inference from the most casual glimpses into the past history of our race that the development of civilization has been largely conditioned on the mingling of different racial strains. It is scarcely too much to say that each of the great civilizations of the past was built by a mixed race. It was so in Egypt, in Assyria, in Greece, and in Rome in the ancient days. It is true of the important races of central Europe and of Great Britain in modern times. And it is pre-eminently true of the American race of our own day.

The point is too obvious for elaboration. No one needs to be told that the colonial stock that came to America in the early part of the seventeenth century was itself made up of mixed ancestral strains. And the most casual inspection of statistics shows to what extent the increase of population of the past hundred years has been due to the coming of immigrants from all parts of Europe, including the representatives of nearly every race of civilized men.

That such mixing of racial strains, within certain limitations, is likely to result in the development of exceptional individuals will not be doubted by any student of the subject, least of all by the plant developer who has produced striking results by a corresponding mingling of divergent types.

But, on the other hand, it cannot escape attention that there are limits of crossbreeding beyond which the plant developer may not advantageously go. If he attempts to combine species of plants that are too widely divergent, he either gets no result or produces inferior progeny. And if the races that are crossed lie just at the limits of affinity, he may produce a progeny, that, particularly in the second and later generations, become so variable and diversified as to run counter in the main to all of his plans and expectations.

We have seen this illustrated in many cases—witness, for instance, the crossing of the tobacco and the petunia, of the European and Chinese quinces, of the oriental and opium poppies, and of the various members of the genus Rubus.

The Need of Selection

In some of these cases, to be sure, individual forms were produced that had very exceptional interest and that might even supply material highly prized by the plant developer for the production of new races.

Front Entrance to the Old Homestead

The Old Homestead stands near the street, with a huge Chilean pine on one side (shown here just at the left edge of the picture), and the famous hybrid elm on the other side. It is almost buried in the massed foliage of vines.

But it must be recalled that the plant developer always has full privilege of excluding the undesirables from the hybrid fraternity. He can pick out one or two individual hybrids showing desirable qualities, and can eliminate the thousands that are unfit.

As a single illustration, let us recall the Phenomenal berry, a hybrid between the California dewberry and the Cuthbert raspberry. It will be recalled that this individual plant was the only one worth preserving out of a hybrid colony of many thousand individuals.

The one valuable plant was carefully preserved and nurtured. The thousands of undesirables were piled in a heap and burned. The blending of different racial strains had produced one highly prized new specific form. Granted the privilege of destroying the undesirables, the experiment was eminently worth making and the results were altogether gratifying

But what if it had been incumbent on the plant developer to preserve the thousands of undesirable hybrids?

Not all of them were altogether obnoxious, to be sure. Yet a very large proportion of them combined racial traits of remote ancestors in such a way as to make them very unfit members of a colony of cultivated plants.

Lacking the selecting hand of the plant developer, which could ruthlessly rout out these undesirables, the net result of the hybridizing experiment would have been to produce a vast colony of brambles far less desirable on the average than their parent forms.

America, the Melting Pot of Nations

Making the application, it becomes at least a very serious question as to whether the recent altogether unprecedented influx of immigrants of many widely divergent races—notably those that have come from the Mediterranean region and Southeastern Europe, from various provinces of Russia, and from the Far East—are not supplying material that, blended with the existing American stock, may produce results as startling and on the whole of as doubtful value as those produced among plants when widely hybridized.

A certain admixture of new strains of these varied races might not be without its advantages. It has been urged that there are qualities of temperament associated with a love of music and the arts characterizing the Latin races, for example, that might advantageously be mingled with the somewhat cold and practical temperament of the American race, to give it a new quality, just as new flavors are bred into the racial strains of plums or pears or peaches.

Mr. Burbank's Home Yard Filled With Red Poppies

This is a view just across the road from the Old Homestead, where Mr. Burbank's present home is located. The door-yard made a wonderful display when the poppy experiments were in session, as this picture suggests.

There is no gainsaying the possibility that such blending may have its advantages. But there seems danger at the moment that the matter may be overdone.

When we read of the coming of as many as a million three hundred thousand aliens in a single year; and when we are told that of those that come from Southeastern Europe more than 35 per cent. are of such undeveloped or atavistic types that they are unable to read or write—we cannot escape a feeling of solicitude over the introduction of so high a percentage of blood of so doubtful a character into the strains of our developed colony of American races.

It must be recalled that when the plant developer brings from Japan or from Europe or from Asia a new race of plants to combine with his native stock, he selects always the very best individuals that are to be found. Very commonly he breeds the newcomers for successive generations and makes repeated selections before he finds an individual suitable for his hybridizing experiment.

He knows very well that if he were to choose inferior members of any stock for his experiments he would be working in the wrong direction, and could not hope to produce improved races.

But the immigrants that are flooding in on us, in particular those that come from Southeastern

Europe, cannot even by the most liberal interpretation be said to represent the best strains of the varied racial stocks from which they have sprung.

They are in large proportion confessedly inferior representatives of their races.

There is much evidence to show that they even include large numbers of defectives, who, owing to their alien tongues and habits, can with great difficulty be properly adjudged by the immigrant officials and denied admission in accordance with the laws that are intended to prevent the coming of the notoriously unfit.

The Greatest Migration in History

But even if it were supposed that a large majority of newcomers are really representatives of the best of their alien racial strains, their coming in such numbers would still make them objects of solicitude to the student of heredity.

The American race of to-day has been built up along certain lines not only of physical, but of mental and moral development that have adapted it for a social and political environment that is far different from that from which many of these aliens come. Transplantation to the new environment may have a certain effect on the immigrants, just as transplantation to the soil of California has had its effect on large numbers of plants brought from the Tropics.

Side View of Mr. Burbank's House

Mr. Burbank's new house was built only a few years ago, but one side of it is already covered with a beautiful mass of vines, as this picture shows. By way of contrast, note the improved Burbank artichokes that were in blossom at the time when this picture was taken, and hence appear in the foreground.

But in one case, as in the other, such changes are, after all, only matters of minor detail.

A plum tree transplanted from Japan may put out a somewhat larger growth of twigs and a somewhat larger and more highly flavored fruit than was its wont in its native habitat. But at best it remains unmistakably a Japanese plum.

The modifications wrought by the environment are matters of detail; the fundamentals of heredity, built up by thousands of generations of past environments, are fixed beyond immediate change.

Nor can we doubt that the same thing is true of the fundamental physical, mental, and moral traits of the alien races that make up the great army of immigrants that come to our ports in such numbers as to make their migration, in all probability, by far the largest and most rapid migration of human races that ever took place in the history of the world.

The total number of immigrants that have come to America since 1880—within the compass, therefore, of a single generation—is more than twenty million.

This is a number in excess of the total population of America at any census prior to 1850.

Such an influx of new blood must of necessity change in very large measure the aggregate heredity of the population of America. Whatever the

American race was in the middle of the nineteenth century, it is something far different to-day. That at least is axiomatic, regardless of our estimate as to whether the change has been an improvement or otherwise.

The aggregate status of the population of the plant colonies at Santa Rosa and Sebastopol to-day has probably not more greatly changed from the status of the colonies of 1886 than has the average status of the American race changed in the same period.

Doubtless it would be impossible for anyone to gauge accurately the precise character of the modifications in one case or the other.

But in general terms it may safely be affirmed that the members of the plant colonies have vastly improved in the sense that they have been modified as to leaf or flower or fruit in such wise as to make them better adapted to meet the needs and tastes and desires of men.

Whether the crossbred population of America has been similarly improved in its average adjustment to the needs of a highly evolved social environment is a question that we shall not, at the moment, attempt to decide.

Here, as before, it suffices to point out the conditions and to suggest analogies with the crossbred plant colonies; but here also we must not

overlook the fact that the plant developer's privilege of weeding out the unfit members of his hybrid colony may change the entire complexion of the situation.

Cousin Marriages

As to all this we are taking a wide view and considering the American race as a whole.

But in making the final interpretation, it will be well to glance a moment at the needs of the individual and to make application of one or two principles of heredity to individual cases.

In so doing we are no longer considering the question of the mingling of different racial strains but more particularly the blending of individual traits as presented in marriages contracted by persons of the same race and even of the same community.

Here we are obviously concerned with problems similar to those that confront the plant developer who is making selection among the members of an inbred colony, where his cross-pollenizings do not involve different species or varieties but only members of the same fraternity or of closely related fraternities.

In such a case, it is axiomatic to say that the plant developer selects the individual plants that come nearest to his ideal, and combines them.

But of course it often happens that the plant

Another View of The Old Homestead

If Mr. Burbank were still living in the Old Homestead, it is likely that he would not allow the vines to grow quite so luxuriantly; but to the officers of The Luther Burbank Society it seems highly appropriate that Mr. Burbank's old home should be veritably embowered in foliage. For a still more recent picture of the Old Homestead, see the succeeding photograph.

developer is looking for the production or the accentuation of some quality that may be said to constitute an abnormality; whereas the human eugenist is concerned above everything else with the accentuation of normal qualities and the elimination of the elements of abnormality. Nevertheless the experiments of the plant developer may afford a demonstration of principles of heredity that are susceptible of useful application.

It is fairly demonstrated, for example, that there is no necessary deterioration brought about by the crossing of plants that are related in the degree which in the case of human beings we describe as cousinship. If the strain is normal and healthy, and in particular if the cousins have grown up under different environment, there is no inherent objection to their mating. That is to say, there is no hereditary reason why they may not produce normal and healthy offspring. The great difficulty, however, is that very few families are quite free from one taint or another of disease or infirmity, and the mating of cousins brings together the hereditary factors for this defect in such combination as to accentuate them, and enhance the probability that the defect will make itself manifest in the offspring.

Take, for example, the case of the wild heuchera with the crinkled leaf from which it proved

feasible, by inbreeding, to develop a race of crinkled-leaved heuchera. It would have been impossible to develop and fix this race so rapidly had pains been taken to cross the plant showing the peculiarity with a normal plant, instead of crossing it with a cousin showing the same peculiarity.

In quite the same way such a human abnormality as a tendency to deafness or a malady of the eyes or feeblemindedness or susceptibility to tuberculosis may be accentuated through cousin marriages and thus brought out in the progeny, where, had mating occurred with a normal strain, the tendency might have been indefinitely submerged or even eliminated.

Mendelism and Human Maladies

It has been shown that the phenomena of Mendelian inheritance apply to a number of abnormal conditions to which human beings are subject. It seems fairly established, for example, that normality of mind and feeblemindedness constitute a Mendelian pair of unit characters or unit groups in which normality is dominant and feeblemindedness recessive.

It follows that the offspring of a normal individual and a feebleminded one may be all normal in mind; and if these individuals mate exclusively with normal individuals, the character for feeblemindedness may be permanently submerged.

But, on the other hand, if the individual normal offspring of the first filial generation were to mate with other individuals having the same heritage, the recessive trait of feeblemindedness would reappear in a certain proportion of their offspring.

Obviously cousin marriages give opportunity for the bringing together of such recessive traits, and hence may cause the reappearance in the offspring of undesirable or abnormal characters that might otherwise be suppressed.

In the celebrated series of experiments made by Professor Biffin at Cambridge, England, it was shown that susceptibility of wheat to the fungous disease known as rust is transmitted as a factor dominant to immunity.

Similarly it has been observed that immunity to attacks of the aphis shown by the roots of the Northern Spy apple is a recessive trait and hence that the seedlings from the Northern Spy may be susceptible.

These illustrations, among others, show that susceptibility and immunity to disease may constitute a Mendelian pair of factors that are transmitted in a definite way. There is a growing body of evidence to show that the same thing is true with the human subject in case of susceptibility to certain microbic diseases.

But it fortunately happens that in some cases,

The Old Homestead As It Is To-day

It will be seen that the foliage has been allowed to run riot, until the house itself has almost entirely disappeared. This type of decoration is surely carried to an extreme, but the effect is at once suggestive and pleasing. Such a vine-clad domicile seems an appropriate home for The Luther Burbank Society, and the foliage of the famous hybrid elm forms an attractive background.

at any rate, immunity to disease appears to be dominant and susceptibility recessive, so that the offspring of an immune and a susceptible individual are all immune.

This appears to be the case, for example, with susceptibility to tuberculosis.

The children of an immune and a susceptible person appear to be immune, or relatively immune, to the disease. And this is obviously a fact of the very highest practical importance.

But we must recall that the children who are thus individually immune contain in their germ plasm the factors for susceptibility. So such individuals should exercise the utmost precaution not to marry into families where there is a corresponding taint of susceptibility to tuberculosis, even though the individuals they select as marriage partners are themselves healthy.

Here as in the other case just cited, the union of two individuals who carry the hereditary factors of susceptibility submerged in their germ plasm will result in the reappearance of susceptibility as a tangible trait in about one in four of the offspring.

Stated otherwise, in more general terms, it appears that there are a good many human traits that are blended in such wise in the offspring of a given pair of parents who present the trait, as to

cause the undesirable trait to be latent and thus seemingly to disappear from the fraternity; but that a segregation and recombination of the hereditary factors may occur in the next generation in such wise that the undesirable trait reappears.

We have just seen that the matings of persons who carry an hereditary taint, yet who themselves are normal, will determine whether that taint will reappear in their offspring or whether the offspring will be normal.

In selecting a marriage partner, then, you are selecting hereditary potentialities for your future offspring. And in selecting environing influences —in the broadest sense—for the offspring from the hour of their birth, you are largely determining whether the best or the worst of those hereditary potentialities shall become realities.

In a word, then, we might advantageously apply to the human plant the same general principle which we saw to be the most fundamental one guiding us in our plant experiments, saying that here, no less than in case of the actual plant, selection is the first and last word.

What was said in concluding an earlier chapter with reference to plant breeding, may now advantageously be repeated with reference to the breeding of human beings: "The beginning is selection, and the end is selection."

The Luther Burbank Society

—What It Has Done and What It Proposes

ASIDE from the unquestioned value of his own personal researches, the world owes much to Prof. Hugo de Vries of the University of Amsterdam in Holland. It was Prof. de Vries who discovered the writings of the monk Mendel and interpreted them to the world.

And it was Prof. de Vries, who through a characteristic description of Luther Burbank's work set in motion the train of thought which later crystallized into The Luther Burbank Society, an organization brought together for the express purpose of making Mr. Burbank's life work available to the masses; an organization without which, it is quite likely, the world for many generations to come would never have profited by the labors of the modest plant experimenter of Santa Rosa.

The particular thing which Prof. de Vries said came in connection with an appreciative account

of Luther Burbank's work and was a vivid estimate of the tangible value to the world which even minor improvements in industrial plants are capable of producing.

"In the light of what has been accomplished", said Prof. de Vries after a visit to Luther Burbank's Experiment Farm, "it seems quite possible to breed a new wheat, a new barley, new oats and new corn, which will produce one grain more to each head; or to bring out a new variety of potato which will surpass the original kind, by the addition of a single tuber to each plant; or to improve a tree to the extent of making it bear one more apple, one more pear or one more nut, upon its branches.

"Such transformations are insignificant, almost, in comparison with the long list of spectacular transformations which have been wrought—insignificant, that is to say, from the standpoint of the plant improver.

"It is only when we contemplate the astounding monetary results that such apparently slight changes produce, that we realize their importance.

"The addition of a single kernel to the ear of corn, would, for example, in the United States alone, produce an extra crop equal to 5,100,000 bushels—an annual addition of millions of dollars to the farmers' pockets.

The Society's Information Bureau

This building, the locus of The Luther Burbank Society's Information Bureau, stands at the corner of the Burbank experiment garden at Santa Rosa. In this building are kept the archives of The Society as well as an autograph scroll of visiting members. A path leads back directly from it to the Old Homestead shown in the preceding picture.

"The addition of a single extra kernel to the head means a fifteen million bushel annual wheat increase; or a twenty million bushel oats increase; or a two million bushel barley increase.

"A single extra tuber added to each potato plant in America would mean a twenty-one million bushel crop increase, with no more cost for planting, cultivation or care, and the barest fraction of a per cent., only, to be added to the cost of harvesting.

"By such slight transformations as these, year after year, the benefits, small as to the individual plant, but astounding as to the aggregate, would fall into the lap of the agriculturist, not only in America, but everywhere on earth where plants can be made to grow from the soil.

"And if their direct monetary benefits run thus into the millions and hundreds of millions annually, who can estimate the broad upward influence which such plant improvements will have on society at large?

"Truly, they will be felt by all classes of people everywhere—they will be shared even by those who were not aware of their immediate causes."

Hand in hand with Luther Burbank's ambition even in the darkest days of discouragement, and almost from boyhood, was an earnest determination to give to the world the formulae and experi-

ences for which he was paying so dearly. Throughout all those years of patient experiment, he looked always to the day when the art of plant improving would cease to be an oddity and anomaly, and would take its just place as the recognized leader of the useful arts, since everything we eat and wear and have, in some measure, depends upon the things we raise from the soil.

He looked forward, always, toward the day when every locality would have its plant experimenter, every state its men famous for their plant transformations; and to that eventual day when every farm must have its plot, large or small, devoted to the improvement of the things which give it income.

It is not at all to Luther Burbank's discredit that only now, in 1914, instead of in the 90's or 80's his formulae and experiences are being given to the world. Nor is it to the discredit of the world itself, for attempts to accomplish this result have been many.

It is rather to the credit of Luther Burbank, and to the advantage of the world, that the promulgation has been delayed, for, linked with Luther Burbank's determination to give to the world his methods and discoveries, was the equally firm determination to make the presentation popular, easily understandable, readily applicable, so that

Home of the Luther Burbank Press

This building, standing opposite the Court House in Santa Rosa, is occupied by the publishers of this edition.

his message might be sure of producing the greatest measure of good for the greatest number.

It is not a simple task to put experience on paper; to seek and find in a thousand experiments, dismissed as failures, the three or the five important truths they concealed; to glean from the experiments which proved successful the vital discoveries which they have yielded, and to appraise them in order of their real importance; to arrange the facts in orderly piles and to squeeze from the mass of theory, which has gone hand in hand with the practice, those globules of probability necessary to cement together a useful structure.

If we are to benefit by the experience of any man, we must have before us not only the things which he knows, but the things which he believes, arrayed with an eye to relative importance, with facts, figures, formulae, beliefs, theories, purposes and hopes brought together into a state of unified reconciliation.

It would be no small task to put on paper even the simple experience of a shoemaker, a typesetter, or a blacksmith in such a way that his children might benefit by his successes, discoveries and observations. How much less easy, then, to put on paper the experiences of a man who, for forty years, has worked fourteen hours a day in a field, which is all new, unmapped, unknown, almost—

the experiences of a man who has tried more than one hundred thousand separate experiments and produced widely divergent successes by the hundred—to simmer down such experiments and put the results on paper for the man, who, as yet, is hardly aware that such a line of experimentation exists.

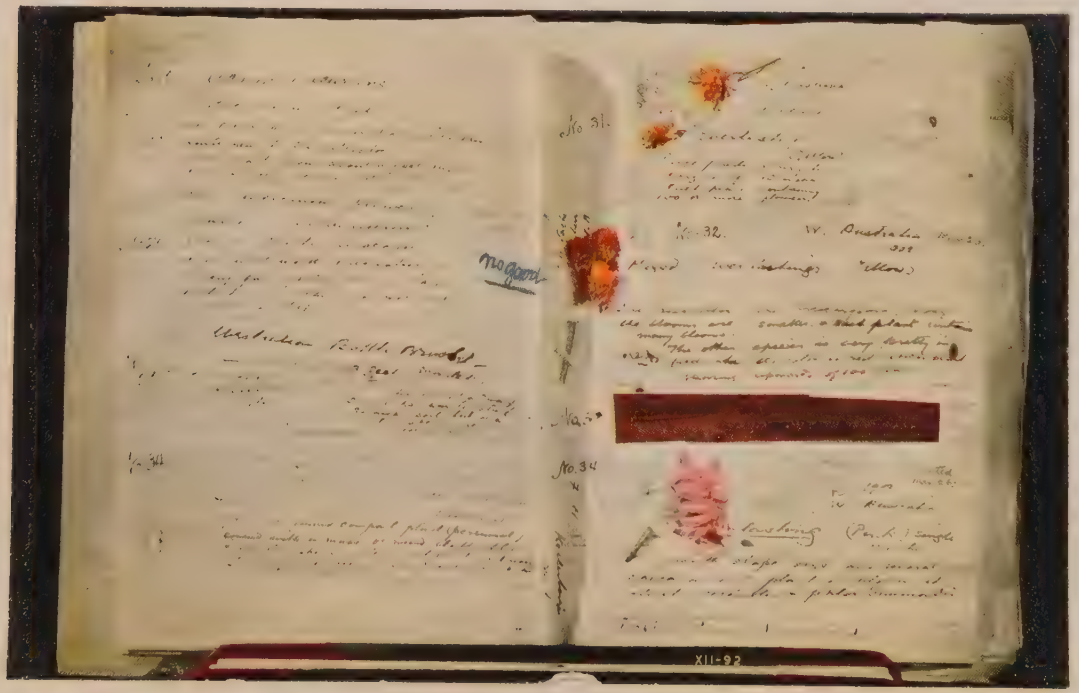
It was the difficulty of the task of presentation which held back Luther Burbank's lifework from the world these past twenty years; not any lack of interest on the part of the world to know, nor any lack of willingness on the part of Luther Burbank to tell.

The best evidence of Luther Burbank's early determination to make the results of his labors available to the world lies in the fact that from the very outset he kept careful, painstaking records of everything that he did. No matter if poverty pinched him, if neighbors criticized him; no matter if series after series of experiments failed him, as experiments often do; and no matter how tired he was at the end of his long workday, he stopped, before retiring, long enough to jot down the record of his doings from sunrise to sunset.

Unique in their simplicity, and characteristic in many ways of their author, these records were filed away as book after book was filled, against the

Burbank Records

In an earlier volume, some of the Burbank records have been shown. It is appropriate that we should revert to the subject in conclusion, and show other samples of these interesting records; more particularly because a mistaken impression has gone abroad that Mr. Burbank does not keep records of his experiments. But in point of fact he has all along kept records of many kinds, and these have altogether exceptional interest for every student of his work.



day when they were to be brought forth and put into tangible shape for the benefit of the many.

The reader will find throughout these pages a number of photographic reproductions which vividly show the painstaking care with which Luther Burbank, almost from boyhood, recorded his experiments.

It was because of this long fixed determination that when the Carnegie Institution of Washington, nearly ten years ago, approached Mr. Burbank, he willingly entered into an arrangement whereby his work was to be given to the world through this agency.

It is not to the discredit of the Carnegie Institution, or to the discredit of Luther Burbank, that this effort, after a great expenditure of money and a number of years of conscientious work, produced no fruit. Most great undertakings experience a number of false starts before they are finally launched on their way to accomplishment. And such was the case with the beginnings of this work.

Laboring alone, and many years in advance of his time, it was not to be expected that Luther Burbank could be interpreted in the language of contemporary science. And in fact, with true Yankee keenness, he much preferred that his benefits be reaped directly by those who practice agri-

culture, rather than by those who merely study agriculture. If both classes could be equally benefited, well and good; but if one had to be slighted, then let it be the studier and not the practicer.

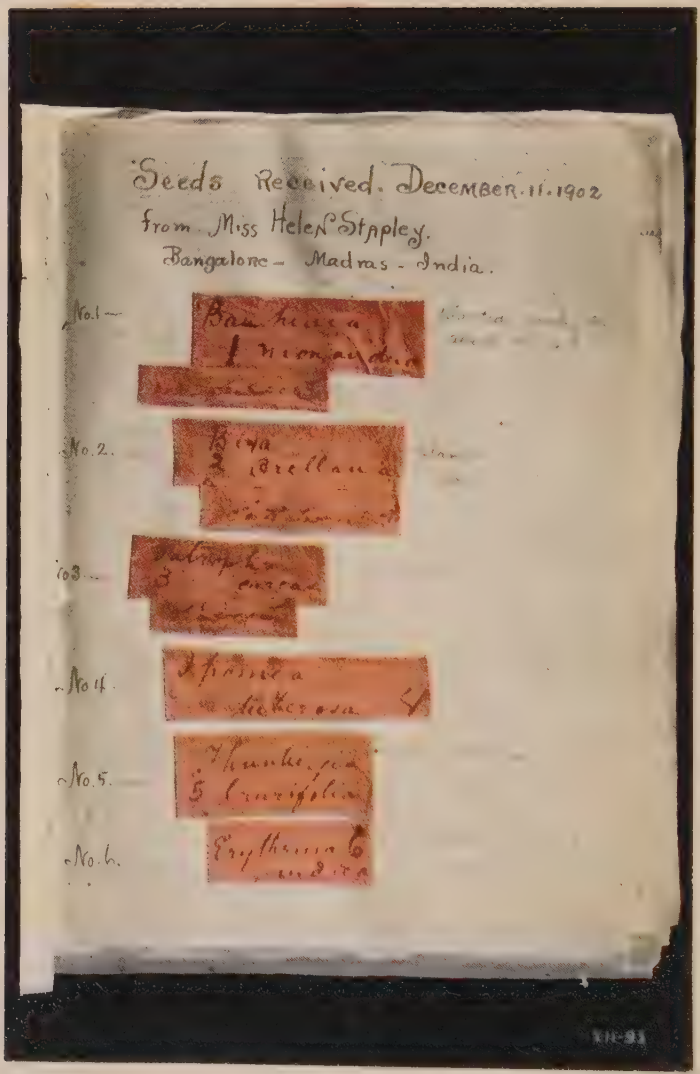
With a willing heart, the able men appointed by the Carnegie Institution co-operated with Mr. Burbank, and the magnitude of the task, whatever the viewpoint, became apparent as page after page of manuscript was boiled together into what promised to become an interminable record.

After a number of years Mr. Burbank saw and keenly realized that the work which had been done fell far short of his ideals—whatever its scientific value, it failed utterly to be the crystal clear presentation for the benefit of the practical man, which had always been his guiding ideal. So the first step toward success ended in what, at the moment, appeared to be but an expensive failure.

So, too, did succeeding steps—when publishers, more or less capable, sought to put together the Burbank records—resulting in nothing.

The commercial publisher of books, figuring costs against profits, is no man to undertake a work of this magnitude in which hundreds of thousands of dollars must be expended before a single sale could be made.

Thus, in the spring of 1912, a well informed



A Record of Foreign Seeds

It will be seen that this is a record of seeds received December 11, 1902, from a collector in India. Mr. Burbank is constantly in receipt of seeds from all parts of the world, most of them coming from people quite unknown to him. Careful record is always kept of the name of the donor, and such contributions are highly appreciated.

analyst of the situation might well have come to the conclusions that: (1) Luther Burbank's methods and discoveries, whether valuable or not, are hardly likely to be given the world in any understandable form, since for so many years so much money had been poured into the enterprise without visible result; (2) the world will continue to enjoy such of Luther Burbank's creations as have been already distributed, but it is not likely that other experimenters will be enabled to take up his work where he is leaving off, while, on the other hand it is extremely likely that the world must wait for many years, perhaps centuries, for a new crop of plant improvers to grow who will catch up with this man who has lived so far ahead of his times; (3) it is quite likely that Luther Burbank, like Mendel, will die unappreciated, not because the world would lack appreciation for such work as his, but because, rather, there seems to be no practical means of communicating to the world what he anxiously desires to tell.

The analyst who would have come to these conclusions need not have been a pessimist; he might well have been an optimist who simply looked the facts in the face.

It was at this stage that The Luther Burbank Society was organized.

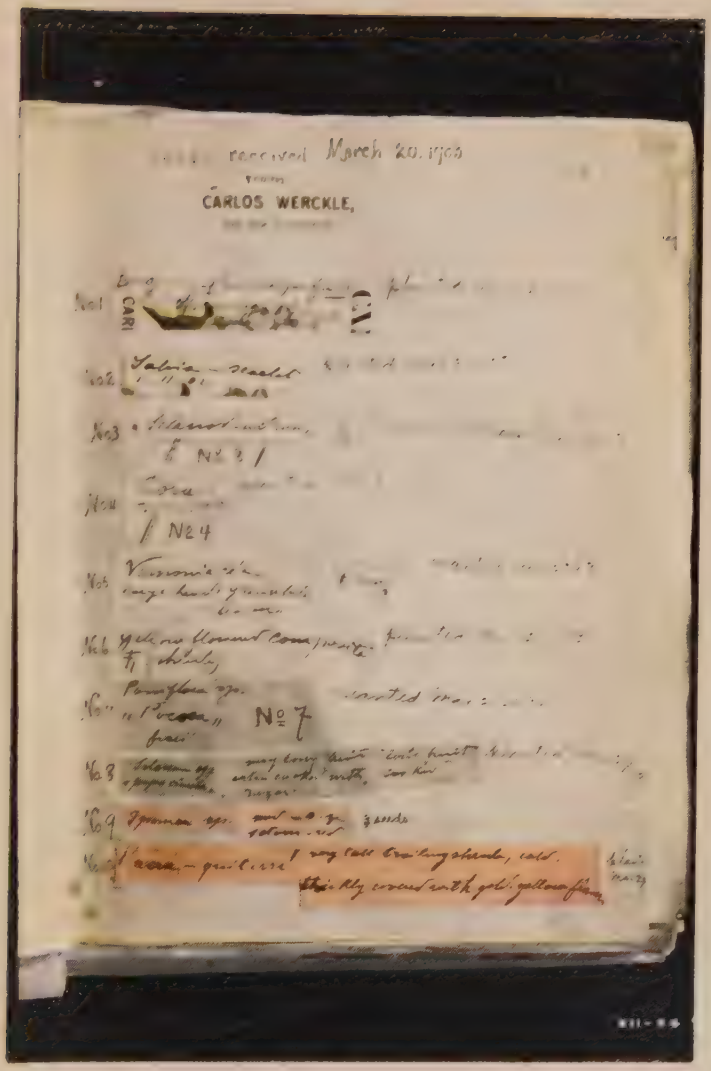
The underlying thought was that where one

may fail, many may succeed; that from the mistakes of the past grow the achievements of the future.

It would have been quite possible for those friends of Luther Burbank who organized The Luther Burbank Society to have enlisted the support of any one of several of America's philanthropic multi-millionaires; but in the light of history, this seemed the least advisable thing to do.

And so, after much consultation and many conferences, the present plan of organization of The Luther Burbank Society was devised—a plan which enlisted the philanthropic support of many members—some fifteen hundred of whom contributed of their means, and some five thousand others of their abilities. In short, the plan of the organizers of The Luther Burbank Society was to interest a large body of philanthropic Americans in the work, feeling that in numbers there was not only strength but safety, and many other elements of success.

With the organization of The Luther Burbank Society in the spring of 1912, it was found that no difficulty was to be experienced in enlisting representative men and women in the movement, so the undertaking was launched, and The Society came into full fledged existence, being chartered by the State of California for the purpose of "collating



Another Record of Foreign Seeds

This time, as will be seen, the seeds are credited to a correspondent in Costa Rica. Observe the seeds are numbered, and that some are named, whereas others are only described as "yellow flowered composite (shrub)," and the like. Note also that the date of planting is recorded. The results will be described in later pages of the record.

Santa Clara County
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and disseminating the methods and discoveries of Luther Burbank of Santa Rosa."

As soon as The Society took definite form, and its financial condition permitted, the work of putting Mr. Burbank's methods and discoveries into manuscript form was actively begun.

That it took just seventeen months to have the first manuscript ready for the printer is no evidence of laxity on the part of those active in The Society's management, but rather serves to illustrate the magnitude of the undertaking, and to convey an idea of the number and obstinacy of the difficulties to be overcome.

There was produced during these seventeen months of apparent idleness enough manuscript to have filled many volumes the size of this present set—not a single word of which appears herein.

This failure, too, to produce definite, tangible results in seventeen months of earnest, strenuous, capable labor, illustrates, too, why the Carnegie Institution, working hand in hand with Mr. Burbank, with its vast resources, and his willing cooperation, failed—and why the publishing firms which afterwards undertook the work had never a chance of accomplishment.

In fact, after seventeen months of what then appeared to be fruitless labor, the management of The Society discovered that a beginning must be

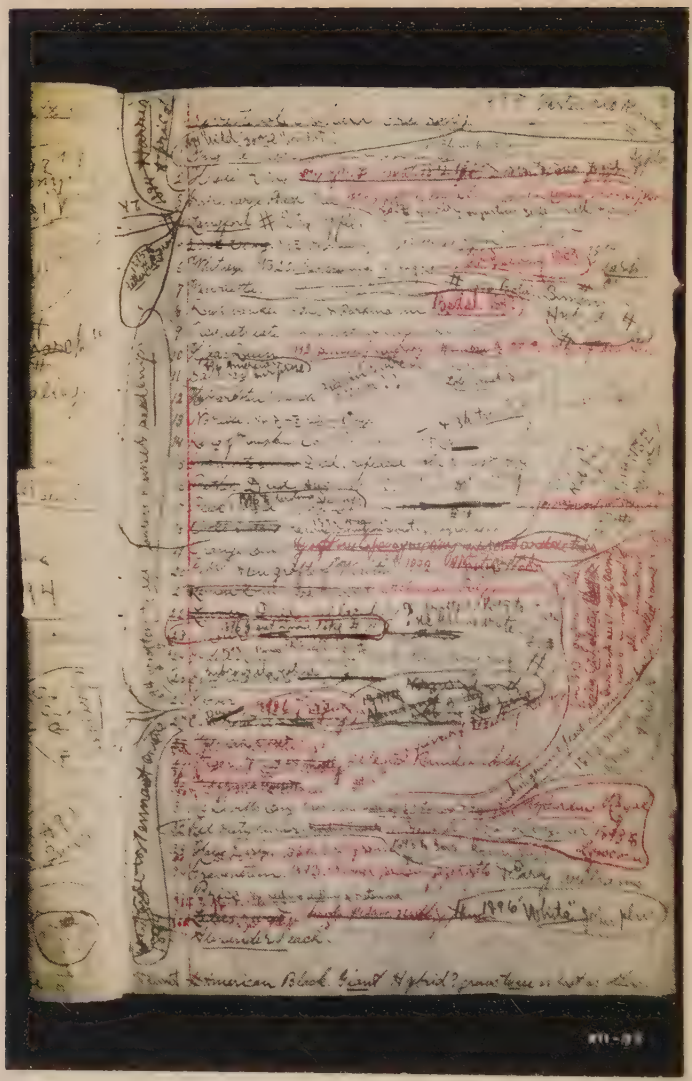
made anew, and that the mass of records must be reclassified, recompared with contemporary science, and rearranged to serve as the backbone of the work.

This, together with the rearrangement of the work done by those who had already been in The Society's employ, was quickly effected, and the whole matter placed in the hands of capable editors, whose scientific and literary qualifications seemed to fit them peculiarly for the task.

As soon as the new editors took charge of The Society's editorial affairs, with Mr. Burbank, as always, loyally giving his time and support, the work in hand began to assume definite final shape, with the result that it was finished, complete, so far as the Editorial Board of The Society and Mr. Burbank were concerned, within six months, or exactly two years, almost to the day, after The Society had received its charter from the state.

Yet with the work done to the satisfaction of Mr. Burbank and of the Editorial Board of The Society, what, from many standpoints, was to be the most important phase of the operation was still to be begun.

This phase, absolutely unique in the making of books, will need a word of explanation here, in order that both its character and its importance may be comprehended.



Record of Orchard Fruits

Here is a page of Mr. Burbank's notes that records data concerning some thirty-seven varieties of fruit that were found in the "Sebastopol orchard, third row," in the year 1895. It will repay careful scrutiny, as illustrating the way in which a busy plant developer saves time and space and yet produces records that are invaluable jogs to the memory.

The trend of modern times, the evolution of things as they are, is to bring the maker of a thing closer and closer to the user of it—to let the eventual user himself decide the characteristics which the maker is to embody in it.

We may take for example, as a parallel, the manufacturer of clothing.

Twenty years ago the maker of clothing designed what he believed his public wanted, and without consulting that public, manufactured large quantities which he sold through wholesale and retail channels, with the result that the public was wearing not the clothes it wanted, but the clothes its makers, several steps removed, believed it wanted. To-day, in the clothing business, the situation is entirely changed. The maker of clothing manufactures not a single garment in advance to carry in stock, but instead designs and executes a wide variety of models, embodying the ideas of the whole range from which the public might like to select. Then with trunks full of these models —models of clothing which can be ordered to be made, rather than samples of clothing already on hand to be sold—the manufacturer's traveling men take to the road, visit the retail stores, which in turn call in their leading customers; and based upon the judgment of the retailer, who is close to the customer, and of the customer himself, the

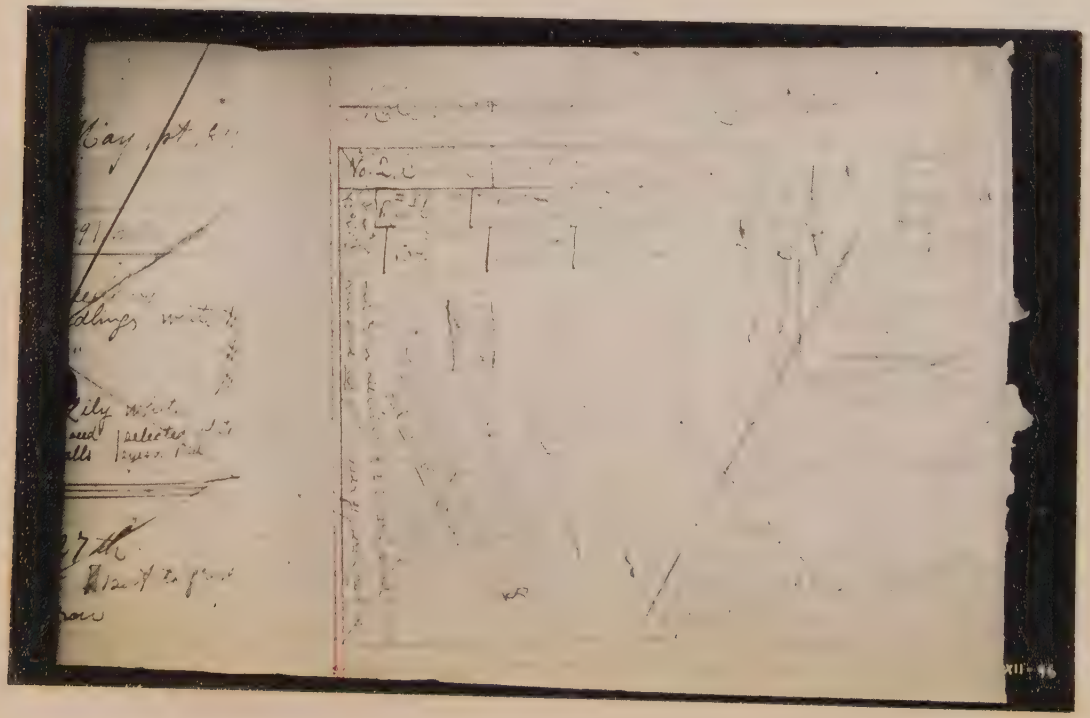
manufacturer takes his orders for the coming year.

It is all, of course, as in plant life, a survival of the fittest. By the old process the manufacturer who made the closest guess survived, while the others perished. By the new process, all manufacturers have an equal chance of survival, because the question of to be or not to be has been propounded to the clothing itself and not to the maker.

So, in almost all lines of trade—which, after all, being the most acute fight for existence, is the most ready exemplar of evolution—the tendency has been to let the ultimate consumer shape, as far as possible the qualities and characteristics of the thing which he is to consume.

In almost all lines of trade this is true, but in the business of writing books this new evolutionary tendency had not as yet made itself evident.

The procedure in the making of books has, as always, been this: The author conceives an idea which he believes to be of interest to a great number of readers; without consultation with those readers he conceives a form of presentation and writes his idea, or ideas into words which are turned over to the publisher; and the publisher, like the old manufacturer of clothing, without consultation with his public, makes such changes in the manuscript as he conceives his public would



A Diagrammatic Record

Here is a record of another type, in which flower beds are charted, and their contents noted, with such comment as the plant developer thinks of value. When you are carrying forward some three thousand different lines of experiment at the same time, it is necessary to adopt shorthand methods. No one who examines Mr. Burbank's books is likely to doubt that the plant developer has a genius for the making of condensed records that are notable for their inclusion of essentials and their exclusion of all non-essentials.

like to have made, and the whole thing is set into hard, cold, unalterable type, and must stand or fall on the goodness of the guesses which the author and the publisher, having no expression from the ultimate consumer, made.

At the outset, the management of The Luther Burbank Society felt that here was a work so vitally important that there was no man living who would be competent of his own knowledge to say whether or not its presentation was perfect; but that instead, irrespective of delay or expense, the public itself, which was to use and benefit from the work, must decide the manner, form and detail of its presentation.

It was this feeling, in fact, which led the founders of The Society to choose its present form of organization instead of enlisting the aid of a single philanthropist.

For the members of The Luther Burbank Society, as it was organized, performed a vastly greater service than the provision of funds for the work, great as that service was; the members themselves, some sixty-five hundred of them in all, representing every walk of life, farmers, bankers, scientists, college professors, business men, city dwellers, suburbanites, small town residents, and open-country farmers, all vitally interested in the work, to these men and women was submitted

the manuscript prepared by Mr. Burbank and the Editorial Board of The Society and it was their suggestions and their comments which determined the final form which appears in these volumes.

Thus it can truly be said of these books that for the first time in the history of book making the manuscript has been submitted to its every possible class of reader before it has gone into type, and that it reflects the composite desire of what its readers want, rather than the imagined desire in the brain of the author and the publisher.

From the brief outline given here, it will be seen that the Editorial Board of The Society found much to do in the preparation of the bare manuscript, itself—yet this was but one phase of its duties. It was realized at the outset that hand in hand with the manuscript there must go illustrations as much better than the ordinary illustrations as the manuscript itself was to be better than the average manuscript.

At the same time that Mr. Burbank turned over to the Editorial Board of The Society his voluminous records, he also turned over some three or four thousand black and white photographs which he had had taken of his productions from time to time throughout the years. At first thought it might have seemed that these photographs would have served admirably to illustrate the text; but a

second consideration would have shown that, beautiful though they were, they fell far short of accomplishing this ideal.

For these were but black and white photographs, and black and white photography as generally practiced, shows form only and little or no color gradation.

That is to say, a bed of brilliant crimson poppies appears in the ordinary black and white photograph as a mass of black flowers.

A bed of beautiful blue balloon flowers appears in the ordinary photograph as though the flowers were white.

In short, it will be seen that with yellow, orange, and red flowers and fruits showing black, and with blue flowers showing white, and with the greens and blue-greens in an intermediate tone, little can be portrayed of a subject which is full of reds and yellows and greens and blues—little justice can be done a subject which is *all* color.

Add to this the fact, which the reader has already gleaned, that color plays a vital part in Mr. Burbank's work, and it will be readily seen that the black and white photographs on hand that April day in 1912, magnificent specimens of the art as they were, were far from suitable for the purposes in mind.

Color Photography Explained—1

In order that a clear understanding may be gained of the process employed in making prints on paper, such as are used in these volumes, a series of nine prints will be shown here. The first of this series, appearing above, shows the primary colors, red, green and blue-violet, and opposite these are their complementary colors, often incorrectly called the primary colors, blue-green, pink, and yellow. Colors are said to be complementary to each other when their separate rays combine to make pure white light. A further explanation of the employment of these colors will be found in the captions of the succeeding pictures of this series.

So, at the same time that the Editorial Board began to assemble its editors, it provided a photochemical laboratory and purchased and brought together in Santa Rosa, at great expense, a complete photographic equipment.

At that time the beautiful color photography process of Lumiere of Paris was just beginning to gain headway in the United States, though a nation-wide search failed to reveal an operator well enough versed in the system to produce a high percentage of satisfactory results. Experiments were taken up at first hand, however, with the result that in The Society's own laboratory it was soon possible to produce uniformly perfect reproductions on glass, in natural color, with great fidelity.

It is doubtful if any other operator in this method in the world has attained such efficiency in working the color-photography process as was attained in the laboratories of The Society—yet this, as it developed, was but a beginning. The process rendered beautiful color reproductions, but in many ways these were inaccurate and the plates themselves were far from being sensitive enough to permit of the short exposures which fruits on the tree and flowers in the garden require.

Thus, during the course of a number of months, The Society's experimenters worked out a much

BLUE

BLUE

BLUE

X11-98

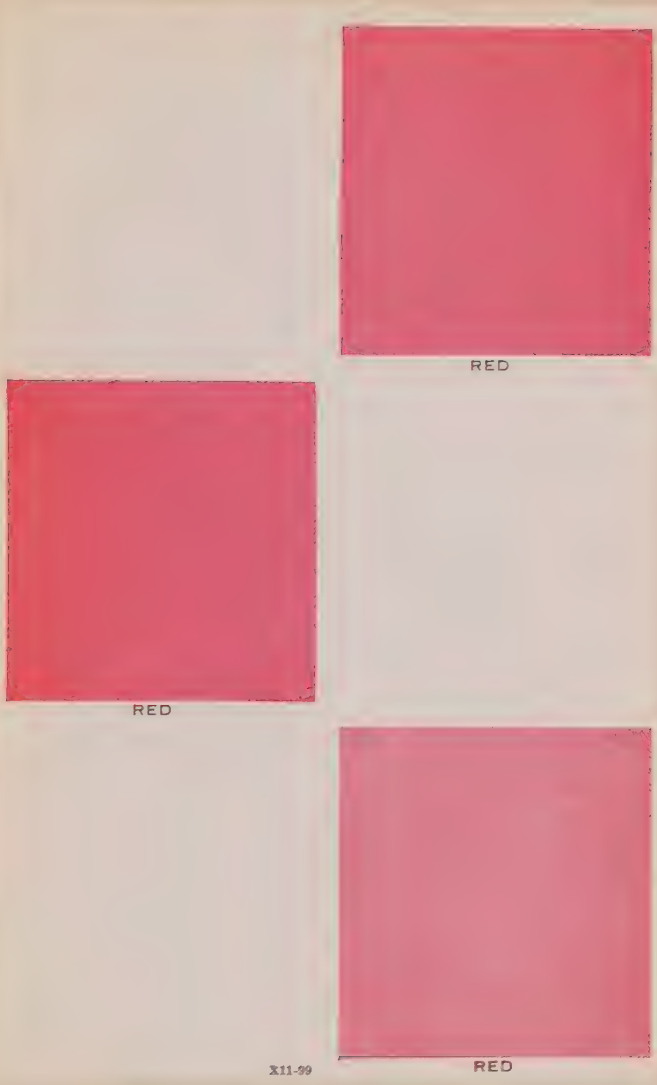
Color Photography Explained—2

The first step in reproducing a print on paper is to separate the color positive made in the camera into its three respective elements, namely its orange-red element, its green element and its blue-violet element. This is done by photographing the color positive successively through glasses covered with colored gelatine corresponding to the three primary colors. For reasons which will be explained later, the printing is made not in the primary color but in its complementary color. This picture shows the negative made by the orange-red separation filter, printed in its complementary blue-green.

more highly perfected method than that with which they began, enabling them to render every color with absolute fidelity, even the most delicate shades, and to obtain color records in the camera in one-thirtieth and one-fiftieth of a second, which, from all practical aspects may be called instantaneous exposures.

Once all the factors of this new method were perfected, the systematic recording of all of Mr. Burbank's products and methods was begun. It was found, however, that many of the subjects which had been illustrated by the black and white photographs had wholly disappeared; and in order that the color records might be complete, Mr. Burbank re-performed many of his old experiments, so that color photographs might be taken of them. Every experiment which Mr. Burbank had under way, and those which he undertook a second time were carefully photographed in color, and then The Society's staff of photographers was dispatched to different parts of the United States for the purpose of securing such illustrations as could not be obtained on the home grounds, but which were needed to make the work complete. In all, nearly twelve thousand color plates were made, about ten per cent. of which, or 1,260, are reproduced in these volumes.

As soon as the photographing of the subjects



Color Photography Explained—3

This picture shows the second successive color separation, namely the one made through the green gelatine coated glass, printed in the complementary pink. It will be seen that each separation cuts out its own color, making it appear white, and lets the other two colors in, graded according to their intensity.

had been put under definite way, the next difficulty to be overcome was that of reproducing these on paper, for use in the books, monographs and other publications of The Society.

At the time these experiments were undertaken, nothing whatever of practical value had been accomplished along this line, and the work which The Society's experimenters did may be judged by the color prints on paper in these volumes.

With the text complete and in the hands of the members of The Society for corrections and suggestions, and with the color illustrations prepared and a means of reproducing them on paper devised, there were yet many minor, but none the less difficult, problems to be surmounted. The problem of binding alone, because of the tipping in of 1,200 separate color prints, was entirely new and required unique treatment. It seems hardly worthy of great explanation at this point, but if the reader were to see the hundreds of sample volumes submitted by various binderies and to compare them with the new method devised for the purpose and embodied in these books, he would at once realize that many months of concentrated study were devoted to this subject.

The text printing, the type made from The Society's own matrices, the paper made according

Color Photography Explained—4

This shows the third successive stage in separating the elements of a color positive—it is the picture made through the blue-violet dyed gelatine color filter, printed in its complementary yellow. The original color positive with which we started has now been separated into its elements and the next stage, beginning with the following picture, will be to recompose it on paper.

to The Society's own specifications in a special mill run, all of these and many other details, small individually but large in the aggregate, proved time-consuming, energy-eating problems, which had to be solved.

It will be seen, thus, that The Society's first work was to arrange and classify Mr. Burbank's voluminous records, covering the entire field of his experiments, to make the necessary comparisons with contemporary science, and to write the whole, first into a lucid, easily understood exposition at the same time illustrating all of his methods and discoveries in natural color, and to put the whole into book form so that each phase of every operation might be made crystal clear to the reader, whether his interest be general or specific.

With the completion of these twelve volumes the first cycle of The Society's operations thus is accomplished.

But it is not meant by this that The Society's work is at an end—in fact the most important work is yet to come.

With all of Mr. Burbank's work charted, mapped, analyzed, classified, with contemporary science and practice placed in parallel in accessible form, and with all of the records of State and Government Experiment Stations and many records generously donated by individual experimenters,

Color Photography Explained—5

In this picture the green and blue-violet separations, last shown, are here superimposed in their complementary pink and yellow. It is possible to gain the same effect by recomposing the original colors of the separation, but for several reasons this is not the most practical method of operation. One reason is that the separations such as the last three shown are really negatives and by printing the negative in the complementary color the result is theoretically the same as would be gained by printing a positive in the original color.

The Society has at its command a fund of usable information such as has never before been brought together in the interest of a single line of knowledge.

All that has been hoped of the present volumes, of which this is the concluding one, is that they will serve to stir up a broader interest than has ever been known in this vital subject; that they will acquaint the general reader with the importance of the work and give the practical beginner a fair start toward his goal. All that has been expected of these volumes is that they will be the beginning of what must become a world-wide movement.

If The Society's work is to reach its maximum result, this set of books must be but the forerunner of many millions of pieces of printed matter which shall give guidance to those who take up the study of improving living things, whether plant or human. And for this work there is already in The Society's vaults ample material on hand.

Already, coincident to the publication of these books, The Society has found the time and means to publish and prepare for distribution a series of monographs, each dealing with some specific phase of gardening, fruit growing, flower raising, farm management, and kindred subjects. Already there has been prepared a separate series dealing with the improvement of the human plant, consisting

Color Photography Explained—6

This shows another phase of the recomposition, being the green and red separation plates printed in their complementary pink and blue. It will be noted that in the last picture the pink and yellow combine to make the spectral red, which has no blue in it; while in this picture the pink and blue-green combine to make the spectral blue-violet, which has no yellow in it.

of a number of monographs covering as broadly as possible within the space at hand, the whole subject of heredity and environment as applied not only to the production of better races but to the production of better individuals.

In all some two million pieces of educational printed matter of one kind and another have been distributed.

That this is but the beginning, however, may be seen from the comprehensive plans already laid out which include the following:

First. The preparation of a series of even more intensive monographs on the improvement of the human plant, with specific illustrations from many sources, and with the definite applications brought home as closely as possible to the individual reader.

Second. The preparation of a series of popular monographs on the application of mental forces to the improvement of individual human life—physical and moral—from facts which have come as a sidelight to Mr. Burbank's work.

Third. The preparation of a series of popular monographs on specific farm methods, showing the most profitable plants and crops, differentiated by climates and localities, with a view to getting the average agriculturist out of his rut and forging forward on a better plane.

Color Photography Explained—7

In this picture the blue and red separation negatives are shown as printed in their respective complementary yellow and blue-green colors. Here it will be seen that the yellow and blue-green together make up the spectral green shown in the first print, and that this illustration, together with the last two have each combined to produce one of the three original colors.

Fourth. The preparation of a series of large wall charts describing and illustrating, in natural color, flowers, fruits, vegetables, trees, grains and grasses—a graphic method of nature study for children, which educational authorities have pronounced more efficient and practical than the present botanies in book form.

Fifth. The organization of a lecture bureau and the preparation of motion picture films for the illustration of improved methods, to be sent throughout the rural districts and throughout the cities and towns as well, for the purpose of vividly illustrating the necessity of the work and the means of accomplishing results.

Sixth. The classification of all records and data not now classified, with a view to inaugurating an individual information service for all those engaged in, or interested in soil culture.

Seventh. The publication of a periodical presenting the actual experiences—successes and failures—of those engaged in or interested in plant or human improvement, affording a forum for the profitable exchange of practices and ideas.

Eighth. Additional laboratory work with color photography, with a view to making it more widely available, with the idea that the public should benefit by all of The Society's activities, of which this has by no means been an unimportant part.

Color Photography Explained—8

In this illustration we see the red, green and blue-violet separation negatives recomposed in their complementary colors of blue-green, pink and yellow, with the result that a print on paper is produced which corresponds exactly with the original copy shown in number one of this series. The recomposition may be made either by photographic or mechanical means, a combination of many well known processes, however, giving the best results.

Ninth. The preparation and publication of text books for popular and schoolroom use, to be issued through some commercial publishing house, with the idea that the royalties derived from these and other publications will provide a permanent source of income to sustain The Society in its work.

As to finances, The Society's expenses have been promptly met by the subscriptions of the Life Members, with the result that the progress already described has been achieved, and The Society finds itself clear and free of debt.

The sale of a popular edition of this first exposition in twelve volumes has been placed in the hands of publishers on a basis which will insure The Society an annual income without recourse to the solicitation of contributions; and the sale of other later publications, including text books, will be placed in the hands of publishers on a royalty basis, so that not only has the success of the original idea been achieved, but, in addition, preparation has been made for the furtherance of The Society's work in the future.

Inspired by the observation of Prof. Hugo de Vries, the organizers of The Society may well feel that the popular response to The Society's announcements gives ample proof that interest is not lacking; and the promise of the Future, from the work already done, is not only that Luther Bur-

Color Photography Explained—9

In this illustration is shown some of the special equipment devised for this work. These lamps, of nearly nine thousand candle power, were used in making a number of the pictures which could be made indoors—such as those of flowers and fruits which could be brought to the laboratory. It will be noted that the reflecting surfaces of these lamps, instead of being white, are a yellow-green, which color was used for the purpose of correcting the color of the light itself, a device of one of The Society's experimenters which it is believed was for the first time employed in this work.

bank's work will be continued, instead of being permitted to die with him, but that it will be continued on a much vaster scale and that the world will soon profit from the efforts of a thousand new Luther Burbanks, scattered everywhere, who have the advantage of avoiding most of his discouragements and many of his failures—who, in a word, take up the work where he leaves off.

[End of Volume XII.]

—The addition of a single kernel to the car of corn, would, in the United States alone, produce an extra annual crop of 5,100,000 bushels.

List of Direct Color Photograph Prints in Volume XII

Abutilon

Page

The Abutilon or Flowering Maple..... 208

Apples

Gathering Apples at Sebastopol..... 54

Blue Flag

The Blue Flag..... 211

Luther Burbank

Burbank Day at Santa Rosa.....Frontispiece
Mr. Burbank's Mother..... 6
Luther Burbank's Birthplace..... 9
Where Luther Burbank Was Schooled..... 12
Luther Burbank at the Age of Nine 15
Luther Burbank at the Age of Fourteen 17
Luther Burbank at the Age of Seventeen 19
Luther Burbank at the Age of Twenty-five 21
Luther Burbank at the Age of Fifty 106
Mr. Burbank's New Home in Santa Rosa..... 141
Mr. Burbank's Porch 143
Another View of Mr. Burbank's Porch..... 145
Mr. Burbank's House as Viewed from Across the Street... 147
Mr. Burbank and Dr. Hugo de Vries..... 149
Mr. Burbank Gathering Poppies..... 152
Mr. Burbank with a Gigantic Crinum Bulb..... 157
Mr. Burbank in an Oriental Setting..... 160
Mr. Burbank's Home Yard Filled with Red Poppies..... 233
Side View of Mr. Burbank's Home..... 236

Luther Burbank Homestead

Page
The Old Homestead in Autumn..... 224
Rear of the Old Homestead..... 227
Front Entrance to the Old Homestead..... 230
Another View of the Old Homestead..... 240
Old Homestead as it is To-day..... 244

Luther Burbank Society

The Society's Information Bureau..... 249
Home of the Luther Burbank Press..... 252

Book for the Blind

A Burbank Book for the Blind..... 163

Calceolaria

The Calceolaria..... 218

Cherry Orchard

A Burbank Cherry Orchard..... 190

Color Photography

.....271, 273, 275, 277, 279, 281, 283, 285, 287

Dandelion

A Selected Dandelion..... 221

Grape Vineyard

A Paying Burbank Grape Vineyard..... 196

Medals

A Burbank Product Highly Honored..... 166
A Burbank Medal 169
Another Burbank Medal..... 172
A Medal from the California Academy of Sciences..... 175
A Gold Medal from the Pan-American Exposition..... 178
A Medal from the California State Agricultural Society.... 181
A Medal from the California State Floral Society..... 184

Parrot Bill Flower

The Parrot Bill Flower or Clianthus..... 215

Pears

An Improved Bartlett Pear Orchard..... 199

Planting

Page
Marking Rows for Planting 39

Potatoes

The Purchaser of the Burbank Potato 25
Luther Burbank's First Advertisement 57
A Paying Burbank Potato Patch 193

Primroses

A Bed of English Primroses or "Cowslips" 202

Prunes

A Burbank Prune Orchard 187

Records

Burbank Records 255
A Record of Foreign Seeds 258
Another Record of Foreign Seeds 261
Record of Orchard Fruits 264
A Diagrammatic Record 267

Santa Rosa Views

A View at Santa Rosa 60
Another View in Mr. Burbank's Gardens 63
Strange Bedfellows 66
A Santa Rosa Tangle 69
Vegetation of Many Types 71
Quantity Production 73
Mr. Burbank's Back Yard 75
A Bird's-Eye View 77
Midsummer at Santa Rosa 79
Another Midsummer's View 81
Cactus, Canna and Grasses 83
Another View of the Famous Elm 85
Early Autumn at Santa Rosa 87
Over the Strawberry Bed 89
At the Height of the Season 91
Across the Cactus Field 94
Cactus Plants of the Newest Generation 97
At the End of the Conservatory 100
Tropical Luxuriance 103

Sebastopol Views

Bird's-Eye View at Sebastopol 109
Watsonias at Sebastopol 112
Another View at Sebastopol 115
A Near View of the Sebastopol Farm House 118
Days of Preparation at Sebastopol 121

Page
Flowering Time in the Sebastopol Orchard..... 124
Crinum Beds—and Others..... 127
A Briar Patch at Sebastopol..... 129
Gladiolus Beds at Sebastopol..... 132
Cherries, Plumcots and Other Orchard Fruits..... 135
A Sebastopol Pot Pourri..... 138

Scilla

The South American Scilla..... 205

Seeds

Washing Seeds..... 43
Covering Seeds with Sand..... 45
Seeds in the Greenhouse..... 47
Rare Seeds in Common Receptacles..... 49
Seeds Drying in the Open..... 52

Sieves

An Assortment of Sieves..... 33
A Collection of Sieves..... 35

Tools

A Simple but Important Equipment..... 28
A Crude but Effective Implement..... 31
Soil-Stirring Implements 37

Trench

Setting Out Small Seedlings..... 41

LUTHER BURBANK

HIS METHODS AND DISCOVERIES AND THEIR PRACTICAL APPLICATION

PREPARED FROM
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COVERING MORE THAN 100,000 EXPERIMENTS
MADE DURING FORTY YEARS DEVOTED
TO PLANT IMPROVEMENT

WITH THE ASSISTANCE OF
The Luther Burbank Society
AND ITS
ENTIRE MEMBERSHIP

UNDER THE EDITORIAL DIRECTION OF
John Whitson and Robert John
AND
Henry Smith Williams, M. D., LL. D.

SUBJECT INDEX
VOLUMES I-XII

Index to Volumes I to XII

Vol. Page.

A [illegible]

[illegible]

B [illegible]

	Vol.	Page.
Barbary Fig Cactus..	VIII	190
Barberry	I	88
	III	78
	VI	239
"Bark" Grafting	III	178
Barley	VIII	45, 46
	X	188
Barr, Peter	IV	123, 188
Bartlett Pear	IV	26
Bartlett Plum	IV	223
Bassford, H. A.	XI	178
Basswood	II	100
Bateson, Prof.	V	208
Beach Plum	III	72
Bean	VII	96-108
Bean Tree, Jumping	I	98
Bear Story	I	86-88
Beard-Tongue	IX	158
Beauty Plum	V	86, 74, 82, 234
Bequerel	V	242
	VII	111
Bee	I	177
	II	201
	III	208-219
Beech	XI	176
Beecher, Henry Ward.	IV	211
Bell-Flower	X	86, 280
Berberis aciifolia	VI	244
Berberis buxifolia	VI	243
Berberis thunbergii	VI	246
Berberis vulgaris	VI	244
Berberis repens	VI	244
Berberis vulgaris	III	78
	VI	242
Berckmans, J. P.	V	34
Berckmans Plum	V	88
Berger Co., H. H.	VI	246
Bermuda Grass	VIII	293
Beurre Clairgeau Pear	IV	26
Bidens atrosanguinea	IX	226
	X	178
Biffin, Prof. R. F.	III	98, 28, 112
	VIII	54-76, 129
	IX	148
Bignonia	X	227
Birch Tree	XI	292
Bird Cherry	IV	97
Birkeland, Prof. Christian	VIII	105
Birthplace of Burbank	XII	18
Blackberry, Thornless	VI	7-38
Blackberry, White	II	69-72, 97
	III	24
Blackcaps	VI	188
Black cap Raspberry	VI	42
Black Dahlia	IX	226
	X	178
Black Eyed-Susans	X	90
Black Tartarian Cherry	II	211
Blood Plum of Satsuma	V	14, 29
Bloomeria	VII	286
Bloomeria aurea	VII	286
Blossoms of Fruit Trees	V	180
Bluebell	IX	158
Bluebells of Scotland	X	87-89
Blue Grass	X	245, 244
Blue Poppy	IX	104-133
Bodega Red Potatoes	VII	296
Bodinghaus, M.	IX	172

	Vol.	Page.
Body Plasm	X	99, 101
Bolivian Peach	IV	170, 172
Boll-Worm	VIII	122
Bonfire	I	202-206
Bon Silene Rose	IX	45
Bordeaux Mixture	II	180
	IV	50
Boston Ivy	X	215
Bourbon Rose	IX	45
Boxes for Seedlings	III	122
Boyhood of Burbank	XII	7-59
Brandywine Strawberry	VI	96
Brazilian Morning-Glory	X	183
Breeding Giants	IX	72-77
Brevoortia	VII	258
Bridal-Rose	VI	262, 264
Broccoli	VII	61
Brodiaea	VII	252-258
Brodiaea capitata	VII	252, 255, 257
Brodiaea laxfea	VII	254, 255
Brodiaea laxa	VII	255
Brodiaea terrestris	VII	255, 257
Brodiaea volubilis	VII	252
Bromus gigantous	VIII	283
Bromus inermis	VIII	283
Bromus mollis	VIII	286
Broom-corn	VIII	146-150
Brown, Hon. J. T.	VII	282
Brucine	VIII	80
Brunswigia	IX	81
Brussels Sprouts	VII	63
Bryant, Walter	VII	226
	VIII	189
Buckeye	XI	263
Buckwheat	VIII	300
Budding	III	186-195
Bulb Division	X	90-105
Bunting, Isaac	V	14, 15
Burbank Canna	IX	239
Burbank, Prof. Levi Summer	XII	11
Burbank Luther	XII	7-246
Burbank (Luther) Society	XII	247-288
Burbank, Samuel Walton	XII	13
Burbank Cherry	II	226
Burbank Giant Rhubarb	VII	210
Burbank's Hybrid Larkspur	X	173
Burbank Plum	V	26, 38, 70, 270
Burbank Potato	VII	287-294
Burbank Quince	IV	223
Burbank Rose	IX	41-52
Burbank's Sunset Shades of Shirley Poppies	IX	121
Burdock	VII	205
Burpee	IX	211
Burr Clover	VIII	92
Burroughs, John	VI	98
Burrows, Dr. Montrose W.	V	20
Bush Bean	VII	106
Butterfly Experiment.	III	210
Butternuts	XI	54-57

	Vol.	Page.
CABBAGE	VII	60-66
Cactus	I	7-26, 107, 108
	VI	213-236
	VIII	169-289
	XII	51
Cactus Pear	VI	213-236
	VIII	243, 245
California Black Walnut	II	137, 138, 143, 146, 158
	XI	41, 162
California Cactus	VIII	209
California Holly-Leaf Cherry	IV	99
California Lily	VII	262
California Shasta Daisy	II	36
California Thistle	VII	200
California Wild Plum	V	203, 215
Calla	IX	248-257
Calla, Scented	II	73-101
	IX	248
Calyx	III	85
Camassia	VII	239-251
Camassia Cusickii	VII	243, 246
Camassia esculenta	VII	243, 246
Camassia Fraseri	VII	243
Camassia Howellii	VII	243
Camassia Leichtlinii	VII	242
Campanula	X	57-59
Canada Balsam	XI	257
Canada Crookneck Squash	VII	52
Canary Palm	X	209
Candle Berry	XI	266
Canna	IX	235-244
Canna flaccida	IX	236
Canna iridiflora	IX	238
Cannabis sativa	VIII	168
Cape Raspberry	VI	139
Capillarity	VII	18
Capri Fig	IV	297
Capriola	VIII	293
Caraway	VII	155
Carbohydrates	VIII	151-154
Cardoon	VII	186
Carduus marianus	VII	202
Careless Weed	X	267
Carissa grandiflora	IV	302
Carnation	X	119-125
Carnation Flower Poppy	X	153
Carrel, Dr. Alexis	III	145, 146, 147, 148
	V	20, 21
Carrion Beetle	II	74
Carrion Lily	I	80-83
Carrot	VII	69
Carum	VII	282
Carum gairdneri	VII	264
Casaba	XI	264
Casaba Melon	VII	47
Casimirva edulis	IV	302
Castanopsis chrysophylls	XI	122
Castilleia	X	196
Castle, Prof. Wm. E.	II	65, 72, 123, 218
	III	242, 256
Catalina Cherry	IV	99
Catalpa	XI	298
Cathay Pear	IV	226
Cattle Fodder	VIII	209-240
Cauliflower	VII	61
Ceanothus	VI	59
Cecil Bruner Rose	IX	55, 60
Cereals	III	223
Cereus	VIII	172
Chabot Plum	V	38
Chalco Plum	V	223
Chamaerops Excelsa	X	211
Chamaerops excelsior	X	209
Champion Quince	IV	212
"Cheat"	X	283
Chemical Irritability	III	212, 213
Chemical-Yielding Plants	VIII	133-167
Cherimoya	IV	302
Cherry	I	105, 193-210, 264
	II	201-233
	III	13, 20
	IV	14, 22, 69-104
	V	178
Cherry Plum	V	220
Chestnut	XI	7, 14, 95-129, 178, 283
Chestnut Fungus	XI	110-115
Chestnut Oak	XI	124
Chestnut Orchard	XI	115-122
Chewing Gum	XI	258
Chickasaw Plum	V	203, 204
Chico Cactus	VIII	203, 242
Chicory, Wild	I	57
Childs, John Lewis	VI	262
Chilean Bell-Flower	X	230
Chilean Clovers	VIII	82
Chilean Cress	VII	169
Chilean Hemp	VIII	301, 303
Chiloe Squash	VII	58
Chinese Balloon-Flower	X	7-28
Chinese Bellflower	X	38
Chinese Cucumber Quince	IV	223
Chinese Rose	IX	63
Chinquapin	XI	109
Chive	VII	144-151
Chlorophyll Granules	VII	23-38
Choke Cherry	IV	98
Chromosomes	V	221
Cion	III	150
Chrysanthemum lacustre	II	10
Chrysanthemum maximum	II	10, 12
Chrysanthemum nipponicum	II	14
Citranges	IV	278
Citrus Fruits	IV	273-304
Citrus Japonica	IV	275
Citrus trifoliata	IV	273
Cleft Graft	III	172
	IV	270,
Clematis	X	224-228
Clematis coccinea	X	228
Climax Plum	V	223

	Vol.	Page.
Clingstone	V	126-132
Cloudberry	VI	150
Clover	I	46-48
	VIII	78-89, 92-103
Clues To Be Followed	III	13
Coast Tree Lupine	IX	158
Coates, Leonard	V	107
Cocoanut	I	94-96
	XI	13, 14
Codling Moth	IV	50
Coe Chestnut	XI	108
Coffee	IX	247
Colby, G. E.	V	126
Cold Frames	III	120
Collectors	XII	120-123
Colorado Yew Cypress	XI	288
Colors	IX	29-34
	X	271-275
Color Variation in Flowers	IX	155-165, 287
Color of Foliage a Guide	III	287
Color Photography	XII	269-276
Columbine	X	49-57
Colville, Mr.	IX	172
Combination of Qualities	X	13
Combination Plum	II	236
	V	199, 211
Commercial Value of Nuts	XI	17-24
Compositae	III	96
	VII	179
	X	135, 167-197
Composite Flowers	III	96
	VII	179
	X	135, 167-197
Compound Flowers	III	96
	VII	179
	X	135, 167-197
Conchifor	X	80
Conifers	III	120
	XI	172-175, 282-292
Conquest Stoneless Prune	II	112
	V	132-137, 157
Cook, O. F.	VIII	72, 73,
Cook, W. F.	VIII	124, 126
Coquito Rose	IX	63
Coreopsis	X	60-62
Coreopsis linceolita	X	60
Corinth Currants	VI	196
Corn	I	89-92, 126-130
	III	292, 293, 295
	VIII	7-43
Corn Cockle	X	263
Corn Poppy	IX	107
Corolla	III	85, 90
Corona Plumcot	V	299
Correlation of Parts	III	282
Correns	VIII	56
Corsican Pine	XI	257
Cortaderia argentea	VIII	294
Corylus rostrata	XI	149
Cos Lettuce	VII	192
Cosmos	X	178-180
Cotton	VIII	108-132
Cotton Boll-Worm	VIII	122
Coulter, Professor	II	33, 70
Cousin Marriages	XII	239-242
Cover-Crop	IV	48
Cowslip	X	62, 64
Cranberry	VI	166
Crawford Peach	IV	167
Cress	VII	169
Crimson California Popies	IX	121
Crimson Clarkia	IX	158
Crimson Rambler	IX	53, 55, 58, 60
Crinum	IX	81, 97
	X	141-148
Crinum amabale	X	145
Crinum Americanum	IX	97
	X	145
Crinum Anabilis	IX	97
Crinum Asiatica	IX	97
	X	145
Crinum longiflora	IX	97
Crinum moorei	IX	97
Crookes, Sir William	VIII	103
Cross-Pollenizing	II	202
Crozy Canna	IX	236
Crucifers	VII	60-69
Crude Oil	XI	257
"Crystal White" blackberry	II	40, 45, 48, 59, 68
	VI	68
Cucumber	VII	42
Cultivation	X	285
Cup Fungi	VIII	48
Currant	VI	154, 196
Currant Tomato	VII	114
Cut Worm	VIII	122
Cuthbert Raspberry	VI	62, 148
Cuvier	III	282, 283
Cydonian Apple	IV	213
Cydonia japonica	IV	224, 232
Cydonia maulei	IV	224, 232, 234, 236
Cydonia sinensis	IV	206, 224
Cydonia vulgaris	IV	206, 213
Cynoglossum	IX	160
Cypress	XI	288
DAFFODIL	I	130-132
	X	190
Dahl, Dr. Andreas	IX	204
Dahlia	IX	203-233
Dahlia Juarezii	IX	209
Dahlia variabilis	IX	206
Daisy	I	146-162, 182-189
	II	7-38, 59, 97
	III	226-233
	IX	135-165
"Damping Off"	III	140
Dandelion	I	96, 97
	VII	196, 198
Darnel	X	263
Darwin, Charles	II	55, 62, 70, 72, 84, 88, 90, 94
	III	202, 206
	V	40, 44, 46
	IX	168
	X	19
	XI	155, 161, 202, 205, 207
	XII	23, 32, 53, 167

	Vol.	Page.
Darwin, Charles	XII	174, 176, 206
Darwin, Erasmus	IX	168
Darwin Potato	II	283
	VII	297-302
Date Palm	X	200-205
Davenport, Prof.	III	256
Day, H., & Son	II	174
Deciduous Trees	XI	292-301
Delaware Plum	V	36, 70
Delphinium Californica	X	170
Delphinium cardinale	X	168
Delphinium decorum	X	168
Delphinium hespirium	X	170
Delphinium hyemalum	X	168
Delphinium nudicaule	X	168
"Determiner"	II	67, 68
Devil's Claw	I	100-105
Devil's Shoe String	X	283-287
de Vries, Prof. Hugo	II	55, 58, 90, 91, 94-98
	IV	284
	V	139
	VIII	56
	IX	90
	X	68, 70
	XI	198
	XII	153, 194, 200, 247, 286
Dewberry	II	286-289
	VI	11-28, 52
	VI	54, 60-62
Dianthus	X	119-125
Dianthus Chinensis	X	120
Dictator Raspberry	VI	48
Digitalis	III	216
Dill, Egypt	X	240
Dodecatheon	X	62, 64
Dog Corn	VIII	11
Dog and Monkeys Berry	I	170-172
Dooryard Flowers	X	107-134
Dorchester Blackberry	VI	25
Dorsa Plum	V	222
Doubling Petals	IX	34-39
Douglas Spruce	XI	288
Drainage	X	245-252
Drake's Seedling Almond	XI	91
Drooping Nightshade	IX	267
Duarte Plum	V	36
Durfee, Warren	XII	88
EARLY Amber Grape	VI	206
"Early Black" Grape	VI	206
Early Goodrich Potato	VII	290
Early Harvest Blackberry	VI	27
Early Minnesota Sweet Corn	VIII	30
Early Purple Guigne Cherry	II	211
Early Rose Potato	VII	278, 290, 292
Early Pears in Santa Rosa	XII	61-105
East Bend E. M.	IV	276
East Plum	V	211
Easter Beurre Pear	IV	118
Echeveria secunda glauca	VIII	124
Edible Bulbs	X	88
Edison	I	56
	VII	110
Educating the Seedling	XII	223
Eel Grass	III	205
Eggplant	VII	223
Elaeagnus	VI	246
Elaeagnus argentea	VI	248
Elaeagnus augustifolia	VI	248
Elaeagnus canadensis	VI	248
Elaeagnus longipea	VI	246, 248
Elaeagnus pungens	VI	248
Elaeagnus umbellata	VI	248
Elder	VI	175
Elderberry	VI	172-180
Elegance Verbena	X	108
Elm	XI	301-304
Emerson	V	39
	VI	285
Emperor of Japan	II	170
Empress of India Rose	IX	55, 58
Empson, J. H.	VII	74
Empson Peas	VII	73-83
Endothia parasitica	XI	112
Engelmanni	X	216
English Pond Seedling Prune	II	248
Entomophilous	III	60
Epau Potato	VII	262-265
Epiphyllum	VIII	172
	XII	51
Epistatic	IX	129
Epoch Plum	V	214
Erdody	IX	13
Ericaceae	VI	264
Eriobotyra	IV	264
Eschscholtzia	III	290
	IX	121
	X	151
Essential Oils	IX	245
Eucalyptus	XI	168
Euchleana Mexicana	VIII	10
Eureka Raspberry	VI	47, 48
Euridinetal Fungi	VIII	48
Evening Primrose	II	90, 91, 95, 96, 98
	VII	127
	X	68-72
Evergreen Blackberry	VI	153
Evergreen Golden Chestnut	XI	122
Everlasting Flower	X	135-141
Extra-early Sweet Corn	VIII	27, 29
Extreme Variation	X	7-38
Eyde, S.	VIII	105
FAILURES	II	271-304
Fairchild, David G.	VI	11
	VIII	187, 192
Fameuse Apple	IV	191, 192, 194
Famine Preventer	VIII	246, 248
Feijoa	IV	302
Feijoa Sellowiana	IV	302
Fennel Flower of France	I	88
	III	72, 78
Ferns	III	61, 64, 66, 98

	Vol.	Page.
Ferraria	X	77
Fertilizers	IV	49
	X	280, 288, 289
Field Gardens	X	279-304
Fig	IV	297
Fig Guava	IV	302
Filberts	XI	146-150
Final Selection	III	275-304
Finsen, Dr.	II	52
Fire Blight	IV	128
First Plum	V	204
Five-Leafed Ivy	X	215
Fixing Good Traits	III	221-247
Fixing a Type	III	233-247
Flame Tokay Grape	VI	195
Flat-fish	II	92
"Flats"	III	122
Flax	VIII	107
Floral Envelope	IX	289
Floral Firecracker	VII	258
Flower Gardens	X	279-304
Flower Possibilities	IX	7-40
Flowering Peach	IV	162
Flowering Raspberry	VI	258
Food Value of Nuts	XI	10-13
Foreign Collectors	XII	120-123
Formosa Plum	V	74, 223, 252
Four-O'clocks	X	46-49
Foxglove	III	216
Fragaria ananassa	VI	86
Fragaria Californica	VI	92
Fragaria Chiloensis	VI	84
Fragaria grandiflora	VI	86
Fragaria Indica	VI	90
Fragrance	IX	23-29
Fragrance Calla	II	80
	IX	248
Fragrant Verbena	X	107-116
Francheschi, Dr.	X	236
Franquette Walnut	XI	37, 58
Fraud Plum	V	190
Freestone	V	126-132
Freezing	V	20, 21
French Globe Artichoke	VII	182
French Legend about Apples	I	194
French Marigold	X	174
French Prune	II	112
French Robe de Sergeant Prune	V	118
Fresno Cactus	VIII	209
Fruiting	V	180
Fungus	VIII	48
	XI	110-115
GALTON, Sir Francis	III	17, 18
Gandavensis Gladiolus	IX	174
Garber Pear	IV	118
Garden Huckleberry	VI	114, 115
Gardening	VII	7-38
Garden Plants	VII	39
Gardens, Flower and Field	X	279-304
Garden Royal	IV	191, 192, 194
Garlic	VII	152, 154
General Jacqueminot Rose	IX	63
Geranium	I	67-80
	III	214
	X	128-134
Germ Plasm and Body Plasm	X	99, 101
Giant Amaryllis	IX	94
Giant Calla	IX	250, 254, 256
Giant Maritima Plum.	V	206, 210
Giant Prune	II	249
	V	100, 102, 112
Giants, Breeding	IX	72-77
Gilia	IX	160
	X	191
Gladiolus	IX	167-202
Gladiolus blandus	IX	172-174
Gladiolus cardinalis	IX	172
Gladiolus cristis	IX	172
Gladiolus oppositiflorus	IX	174
Gladiolus psittacinus.	IX	172
Gladiolus ramosus	IX	174
Gladstone Raspberry	VI	43
Glucose	VIII	153
Glumes	VIII	60-65
Goethe	VII	139
	IX	168
Gold Ridge Farm	XII	107
Golden Plum	V	70
Golden Rod	I	26
	X	72-76
Golden Russet Apple.	IV	191, 192, 194
Gonohrena	X	139
Goodrich Potato	VII	290
Gooseberry	VI	160
Gophers	IX	183-186
Gould, Mrs.	X	126
Goumi Berry	VI	246, 247, 248
Grafting	I	198-203
	II	148-152, 208
	III	145-195
	IV	270
Grafting Wax	III	180
Grains	VIII	45-76
Grapes	III	286
	VI	181-211
Grasses	VIII	278-299
Gravenstein Apple	IV	138, 191, 194, 202, 203
Gray, Asa	X	62
Gregg Raspberry	VI	48, 50
Gregory, J. J. H.	VII	53, 281, 282, 284
Greyhound Story	IV	90
Groff, H. H.	IX	184
Ground Cherry	VII	225-228
Guatemala Ant	VIII	124
Guinea Pig Experiment	II	65, 123
	III	242
Gumbo	VIII	110
Gummosis	IV	100
Gum Trees	XI	239-269
Gymnocarpa Cactus	VIII	189
HAAS Queen Apple	IV	192
Habit	II	182
Hairy Plum	VI	251
Hale Chestnut	XI	108
Hale Plum	V	70
Hales, Stephen	IV	282, 287
Halsted, Prof. Byron D.	VII	223

	Vol.	Page.
Hand Pollenizing.....	III	91-98
Hanse, Timothy.....	VIII	78
Hansell Raspberry....	VI	148
Hansen, Prof. N. E...	IV	100
	V	215
Hanson, Timothy.....	VIII	78
Hatch, A. T.....	XI	90
Hawthorn	VI	266
Hay	VIII	77-80
Hazelnut	XI	30, 146-150
Heath	VI	264
Hedges	X	278
Helianthus	VII	187
Heliothis armiger....	VIII	122
Helipterum	X	138
Hemp	VIII	108, 301-304
Henbane	VI	112
Herbert, Rev. Dr. Wm.	IX	167, 172
	X	147
	XII	174
Herbertia platensis...	X	80
Herd, John.....	VIII	78
Herd's Grass.....	VIII	78
Hermosa Rose.....	IX	45
Hermosillo Plum.....	V	36
Heterozygote	II	67
	III	241, 245
	IV	76
Heuchera cristata....	IX	7-23
Heuchera micrantha..	IX	7
Hevea	XI	251
Hickory-Nut	XI	131-140, 156-161
Hicoria glabra.....	XI	134
Himalaya Blackberry.	VI	27-38
Hind, Robert.....	VIII	221
Hippeastrum	IX	89, 94
Hippeastrum aulicum.	IX	84, 86
Hippeastrum Johnsoni	IX	81, 84, 86
Hippeastrum reginae.	IX	81, 86
Hippeastrum vittatum	IX	81, 84, 86
Holmes, Robert.....	II	170
Homozygote	II	67, 160
	III	241, 242, 244, 245
	IV	76
Honey Prune.....	V	107
Hops	VIII	154-163
Horse Chestnut.....	XI	263
Horseradish	VII	170
Hovey's Seedling Strawberry	VI	86
Howard, Dr. L. O.....	VIII	121
Hubbard Squash.....	VII	53
Hubbardston Apple...	IV	192
Huckleberry	VI	114, 115, 166
"Huckleberry Plum".	V	208
Hulot Gladiolus.....	IX	198
Human Maladies.....	XII	242-246
Human Plant.....	XII	203-246
Hungarian Prune.....	II	248
	V	100, 112
Hunt, Prof. Thos. F..	VIII	113
Husbands, Senor Jose D.....	XII	123
Husk Tomato.....	VII	225
Hybiscus	VIII	110
Hybridizing, Limits of	III	36
Hyoscyamus niger....	VI	112
Hypericum	X	242
Hypostatic	IX	129

ICE-PLANT	I	48
Iceland Poppy.....	IX	124
Idaho Brome-Grass	VIII	283
Ideal Plum, An.....	V	170-195
Ideal Prune Qualifications	II	245
Improved Dwarf Rocky Mountain Cherry....	IV	101
Improved French Prune	V	107, 109
Improved Strain of Shirley Poppy.....	IX	114
"Inarching"	III	178
Inbreeding	III	224
Indian Fig Cactus....	VIII	190
"Indian-Shot Plant"..	IX	241
Indian's Paint-Brush..	X	196
Inedible Fruits.....	VI	237-268
Inoculation of Soil....	VIII	102
Interesting Aliens....	X	135-166
Ipomoea	X	181
Ipomoea setosa.....	X	183
Iris	III	217
	X	40-46, 77
Iris foetssissima.....	X	42
Iris laevigata.....	X	40
Irrigation	X	252-256
Isabella Regia Grape..	VI	202, 204, 208
Ixia	X	148-150

JACKMANNI lanuginosa	X	219
Jacobean Lily.....	IX	95
Japanese Apricot.....	IV	260
Japanese Golden Mayberry	VI	144
Japanese Ivy.....	X	215
Japanese Plum.....	XI	63-72
Japanese Rose.....	IX	63
Japanese Variegated Corn	VIII	20
Japanese Walnut.....	XI	41
Jerusalem Artichoke..	VII	187
Jewel Weed.....	III	72
Johannsen, Prof. W. L.	II	266-268
Johnson's Amaryllis..	IX	81
Juarez, President.....	IX	209
Juglans cordriformis.	XI	43
Juglans Manschurica..	XI	55
Juglans Sieboldii.....	XI	41
Jumping Bean Tree...	I	98

KAFFIR Corn.....	VIII	14
Kapok	X	194
Keen's Seedling Strawberry	VI	86
Keeping Seeds Over Winter	III	116
Kelep	VIII	124
Kelsey Plum.....	III	158
	V	70
Kelvin, Lord.....	V	240
Kieffer, Peter.....	IV	116
Kimkan	IV	275
King of Italy.....	II	170
Kinkit	IV	275
Kittatiny Blackberry.	VI	25

	Vol.	Page.
Knight, Andrew.....	IV	114
	XII	174
Kohl-rabi	VII	63
Kölreuter	II	44
	XII	176
Kumquat	IV	275
LABELS	III	261-272
Label Stakes.....	III	261-272
Lamarck	IX	168
Lancaster	XII	20
Languedoc Almond...	XI	76
Lapageria	X	230
Larkspur	X	167-173
Latex	XI	252-255
Lawn Beautification..	X	235-278
Lawton Blackberry...	II	42-48, 59, 62
	III	25
	VI	25, 65, 66, 154
Leader Peach.....	IV	167
Leaf	VII	29
Le Conte Pear.....	IV	118, 123
Leeks	VII	152
Leguminous Plants...VIII		98
Le Long, M. B.....	II	252
Lemon, Prof.....	X	174
Lemonball Marigold..	X	176
Lemon Giant Calla...	IX	250
Leopard Lily.....	IX	259
Leotsakos, Prof.....	VI	224, 226
Lettuce	I	48
	VII	190-196
Lichens	III	61, 64
Ligusticum Canadense	VII	157
Lilies	IX	235-268
Lilium auratum.....	IX	71
Lilium Brownii.....	IX	263
	X	88
Lilium Humboldtii...	IX	260
Lilium pardalinum...	VII	262
	IX	259, 262, 265
Lilium parryi.....	IX	260, 262
Lilium parvum.....	IX	260
Lilium Washingtonianum	IX	262
Lily, Chinese Carrion.	I	80-83
Lily of Incas.....	IX	265
Lima Bean.....	VII	102
Limnanthus douglasii.	IX	158
Limits of Hybridizing	III	36
Linden	XI	178
Line Breeding.....	III	242, 247
Linnaeus	VI	150
	IX	204
Lippia canescens.....	X	235
Lippia repens.....	X	117, 235
Liriodendron	XI	294-298
Live Stock Food.....VIII		77-106
Lock, R. H.....VIII		36
Loeb, Prof. Jacques..	III	210, 212
Logan, Judge J. H...	VI	64
Loganberry	VI	64
Lolium	X	263
Longworth, Nicholas..	VI	42
Longworth's Prolific Strawberry	VI	96
Loquat	IV	264-271
Lovage	VII	157
Lovett, T. J.....	II	39, 40
Lumber	XI	155-192

	Vol.	Page.
Lupine	IX	158
Lupulin VIII		156-163
Lye	V	92
Lyscom Apple.....	IV	192
MACADAMIA ternifolia	IV	302
	XI	152
MacDougal, Dr. D. T.	VII	127
Madder	XI	249-251
Madia elegans.....	III	32
Madia sativa.....	III	32
	XI	249
Madrona	VI	265
Magnolia	XI	298
Mahonia	VI	244
Mala Cydonia.....	IV	213
Malta Cactus.....VIII		189
Malthus	XI	205
Mao-li-dzi	VI	251
Maple	XI	178, 239-243
Maple Sugar.....	XI	240
Marchioness of Bute..	IX	206
Marigold	X	174-178
Maritima Plum.....	V	208
Marketable Nuts.....	XI	13-17
Marrow	VII	53
Martin Story.....	II	86, 87, 186
Martynia	I	100-105
Mayberry	VI	144
Mayflower Verbena...	X	107-116
Maynard Plum.....	V	223, 248
Maypop	VII	231-237
McFarland Chestnut..	XI	108
Melissa	VII	163
"Melocotoon"	IV	152
Melon	VII	42-60
Mendel	II	55, 58, 59, 61, 62, 65, 67, 69, 70, 72, 122, 159, 218, 222, 226, 233
	III	25, 241
	V	298
	VI	46, 130, 132, 133
	VII	86-96, 99-100, 106, 108, 117
	VIII	36, 56-72, 87, 129, 182, 260
	IX	127, 130, 299
	X	52, 54, 166
	XI	80, 195-203, 218-237
	XII	192-201, 223, 242-246, 259
Mesambryanthemum ..	X	237
Methyl Alcohol.....VIII		246
Methyl Aldehyde.....VIII		154
Mexican Cotton Boll Weevil VIII		122
Meyer, Frank N.....	XI	112
Mice	IX	127-130
Microcosm	V	239
Micromeria douglassi.	VII	161
Mikado, The.....VIII		271, 272
Mildew	IX	53
Milkweed	I	86
	III	205
	X	193, 194

	Vol.	Page.
Milkweed	XI	252
Miller Prune	V	107, 109
Mint	III	34, 39
	VII	158
	X	64
Miracle Plum	V	156
Mixed Ancestry	III	224
Mixture of Races	XII	226-229
Mojave Lippia	X	241
Moliere	XI	167
Momentum of Variation	III	108
Monarch Strawberry	VI	96
Monkey Puzzle Tree	I	29, 31
Montecito Grape	VI	206
Moon-Flower	X	181, 183
Morada Cactus	VIII	189
Morgan, Prof. T. H.	VII	127
Morganhill Prune	V	107, 109
Morning-Glory	X	181-185, 263-267
Morris, Dr. Robert T.	XI	113
Morton Orange	IV	276
Mosaic of Characters	III	22
Mosses	III	61, 64
Moth	III	198
	IV	50
Mountain Ash	VI	266
Mucilage	VIII	251
Muir Peach	IV	154, 158, 164, 167
	XI	76
Mulberry	IV	297
	VI	172-180
Munson, Mr.	VI	202
Muscat Grape	VI	202
Muskmelon	VII	44
Mustang Grape	VI	200
Mustard	VII	164
Mutation	II	80, 84, 88, 90-98, 120
Myrica cerifera	XI	266
Myrica nagi	XI	268
Myrica rubra	XI	268
Myrobolan Plum	V	116, 174, 220
Myrtles	VI	254-258
Myrtus communis	VI	255
Myrtus ugni	VI	256
NARCISSUS	I	130-132
Nasturtium	X	185-188
Nasturtium Chilensi	VII	169
Natal Plum	IV	302
National Peach	IV	167
Navel Orange	IV	279
Ne Plus Ultra Almond	XI	90
Nectarine	III	120
	IV	141-175
	XI	72-88
Need for Improving Small Fruits	VI	269-304
Nemophila	IX	157
Nettle	I	88
	III	72
New Creations in Fruits and Flowers	XII	136, 137, 153, 155
New Giant Crimson Rhubarb	VII	210
New Plums	V	197-246
New Prunes	V	197-246
Newton, Prof.	III	10
Newtown Pippin Apple	IV	192, 194
Nicotiana Wigandioides rubra	II	275-280
Nicotunia	I	240
Nightshade Family	VI	110
Nitrogen	VIII	96-106
	X	289, 291
Nixie Plum	V	216
Nobel	VII	111
Nonpareil Almond	XI	90
Non-Union Plants	III	61
Nopalia Cactus	VIII	193, 198
Northern Spy Apple	IV	194, 198, 200
Norway Pine	XI	257
Nut Growing	XI	7-33
Nuttall, Dr. G. H. F.	III	48, 50, 147
OAK	XI	175
Oats	VIII	45, 46
Oenothera	X	68-72
Oenothera acaulis	X	70
Old World Thistle	VII	202
Onions	VII	152-155
Opium Poppy	X	151-166
Opulent Peach	IV	156, 158
Opuntia	VIII	172-269
Opuntia vulgaris	VIII	178, 179
Orange	IV	275-292
	V	162
Orange Quince	IV	212, 213, 214, 216, 223
Orange Sugar-Cane	VIII	150
Orange Sweet Corn	VIII	40
Orchard Fruits	IV	7-35
Orchard Grass	VIII	291
Orchard Plans and Methods	IV	37-67
	V	168
Orchard Surgery	IV	128
Orchards	II	150
	V	168
	XI	115-122
Orchid	I	83
	III	206
Orchid-Flowered Canna	IX	239
Orchis mascula	III	206
Orchis pyramidalis	III	207
Oregon Grapes	VI	244
Oriental Poppies	X	151-166
Ornamentals	X	199 233
Ornamental Trees	XI	271-304
Orthogenesis	III	108
Oryza	VIII	275
Osmosis	IV	284, 287
	VII	17, 18
Ostrich Plume Clematis	X	222
Othello Plum	V	222
Out of Door Planting	III	118
Oval Brittany Artichoke	VII	182
Ovary	III	87
Oyster Plant	VII	71
Ox-Eye Daisy	II	8, 10, 12, 17, 20, 26

	Vol.	Page.
PAEONIA Poppy...	X	153
Painted Cup.....	X	194
Palm	III	221
	X	199-214, 277
Palmer Apple.....	IV	192
Pampas-Grass	VIII	145, 294-299
Pansy	I	114-116
Papaver Californica..	IX	123
Papaver orientalis....	X	151
Papaver Rhoeas.....	IX	107
Papaver somnifera....	X	151
Paper	VIII	252, 303, 304
Paper-Shell Walnut...	XI	35-41
Paradox Raspberry...	VI	68, 70, 72
Paradox Walnut.....	II	137, 140, 143, 146, 154, 156, 159, 299
	XI	41-44, 46-51, 164, 167, 193
Paris Artichoke.....	VII	184
Paris Daisy.....	IX	152
Parsley	VII	155
Parsnip	VII	69
Passiflora	VII	231
Passiflora ceurules....	VII	232
Passiflora. edulus....	VII	232
Passion Flower.....	VII	228-237
Pattyan Squash.....	VII	53
Pea	I	263
	II	100
	III	72
	VII	73-97
Peach	III	120
	IV	15, 16, 18, 141-175
	XI	72-88
Peach Blow Rose.....	IX	68
Pear	I	119-125
	III	120
	IV	14, 23, 25, 26, 105-140
Pear Blight.....	IV	126
Pearl Prune.....	V	102, 103, 106
Pecan	XI	24-30, 188-146
Pelargonium	III	214
	X	128-134
Pellier, Louis.....	II	242
Pentstemon barbatus.	IX	158
Pepper, W. H.....	XII	67
Peppergrass	VII	169
Peppers	VII	174-177
Perfection Plum.....	V	70
Perkins	VII	111
Perpetual Artichoke..	VII	184
Persian Rose.....	IX	65
Persian Walnut.....	II	137, 138, 159
	XI	35-54, 162
Persimmon	IV	294
Petunia	II	275-280
	X	125-128
Phenomenal Berry....	II	97
	VI	60
Philadelphia Raspberry	VI	43
Philesia buxifolia....	X	232
Philegeria Veitchii...	X	232
Phoenix	X	206
Phoenix canariensis...	X	209
Physalis	VII	225
Physalis alkekengi...	VII	225
Pierce, J. P.....	VI	204
Pierce Grape.....	VI	202, 204
Pig-Nuts	XI	134
Pineapple Quince.....	IV	211, 221, 222, 223, 224
Pine Strawberry.....	VI	86
Pine Trees.....	I	98-103
	III	120
	XI	175
Pink	X	119-123
Pipewort	I	82
Pipette Rose.....	IX	66
Pistachio	XI	152
Pistil	III	85, 87
Pitcher Plants.....	I	50
Planning a New Plant	III	7-29
Plans of The Society	XII	247-288
Plant Affinities.....	III	31-35
Plant Antagonisms...	III	43
Plant Cells.....	VII	22
Plant's Food Factory	VII	25-31
Plant Intelligence....	III	204
Plants That Tend to Vary	X	17
Plateau	III	213
Platycodon	X	7
Pliny	I	198
Plum	I	275-278
	III	158
	IV	256
	V	7-304
	XI	63
Plum Orchard.....	V	168
Plum, Stoneless.....	II	103-136
	III	110
Plumcot	I	247-252
	IV	18, 256
	V	275-304
"Plums of New York, The"	V	80, 106
Pocket-Gophers	IX	183-186
Pole-Bean	VII	97
Pollenation	I	67-80
	II	202
	III	57-98
	VIII	22, 24, 184, 296
	IX	80, 200, 230, 239, 256, 257
	X	131
	XI	52
Pomato	II	283
Pond's Seedling Prune	V	100
Poppy	I	289-298
	III	290
	IX	103-133
	X	151-166
Portugal Quince.....	IV	212-216, 220, 221
Potato	I	56-65
	II	280-284
	VII	114, 129-144, 267-304
	XII	76
Power of Environment	XII	219-223
Prickly Pear.....	VI	213-236
Pride of Congo Calla	IX	250
Pride Plum.....	V	212
Primrose	II	90, 91, 95, 96, 98
	VII	127

	Vol.	Page.
Primrose	X	68-72
Prunus Berry	II	97
	VI	50-56
Prize Plum	V	36
Prize-Taker Spanish Onion	VII	154
Profusion Amaryllis	IX	92
Prunus pumilaeana	XI	198
Protoplasm	VII	34
Prune	II	102
	V	76-273
	XII	88-90
Prune d'Agen	II	242
	V	98, 100, 102, 107, 112, 115, 126
Pruning	IV	44
Prunus Americana	V	293
Prunus angustifolia	V	246
Prunus Besseyi	IV	100, 101
	V	208, 212
Prunus cerasifera	IV	281
	V	220
Prunus depressa	IV	281
Prunus domestica	V	58, 98, 218
Prunus hortulana	V	293
Prunus Maritima	V	293
Prunus nana	IV	280
Prunus Pennsylvanica	IV	97
Prunus pumila	V	222, 300
Prunus serotina	IV	97
Prunus simonii	V	54, 220, 223
Prunus subcordata	V	293
Prunus tomentosa	V	220
Prunus triflora	V	54, 220, 222
Prunus Virginiana	IV	96
Pseudia graminea	VIII	44
Pumpkin	VII	52
Punnett, Prof.	II	240
Purple-Cane Raspberry	VI	43
Pyrus cathayensis	IV	256

QUADRI-COLORED Corn	VIII	18
Quantity Production	III	96-143
Quercus dentiflorus	XI	194
Quick-Growing Walnut	XI	196-227
Quince	III	126
	IV	206, 211-240

RADISH	VII	98, 98
Radium	VII	127
Ree's Mammoth Quince	IV	212, 220, 221
Rainbow Corn	VIII	16-27
Ramblers	IX	86-90
Rambo Apple	IV	192
Ram Story	II	86
Ranunculus	VII	264
Raspberry	II	291-295
	VI	26-72
Reana luxuriana	VIII	1
Recording Experiments	III	248-272
Red Snow Plant	I	26
Redwood	XI	172, 274-280
Refugee Raspberry	VI	42
Religious Environment of Burbank	XII	29
Resin	XI	256
Rex Begonia	IX	12
Rhode Island Greening Apple	IV	192
Rhodea, Cecil	VIII	278
Rhubarb	II	198-199
	VII	206-222
Ribes divaricatum	VI	162
Ribes menziesii	VI	162
Ribes rubrum	VI	156
Ribes sanguineum	VI	157, 158
Rice	VIII	271-278
Richardia albo-maculata	IX	248
Richardia Elliottiana	IX	251
Richardia hastata	IX	250
Richardia melanoleuca	IX	251
Richardia Nelsonii	IX	251
Richardia Pentlandi	IX	251
Richardia Rehmanni	IX	251
Robinson Plum	V	70
Rocambole	X	128
Roeding, Geo. C.	IV	284
	V	292
Rötiger	VII	111
Rosa, Care of	IV	46
Rosa Chinensis	IX	62
Rosa gymnocarpa	IX	62
Rosa rugosa	IX	62
Rose	IX	41-89
Rose, Olive	XII	14
Rotation of Crops	X	251-264
Rotundifiora	X	59
Rouncy Russet Apple	IV	192
Royal Apricot	IV	282
Royal Walnut	II	127-168
	XI	48-51, 167, 193
Rubber	XI	251-255
Rubio Plum	V	26
Ruma	III	25
	VI	227
Rubus bifrifolius	VI	52
Rubus Canadensis	VI	11
Rubus caperatus	VI	139
Rubus chamemorus	VI	150
Rubus crataegifolius	VI	52
Rubus fruticosus	VI	278, 282
Rubus Idaeus	VI	39
Rubus leucodermis	VI	152
Rubus macropetalus	VI	42, 58, 126, 128
Rubus nigrobaccus	VI	28
Rubus nigrobaccus	VI	40
Rubus nutkanus	VI	258, 260
Rubus occidentalis	VI	42
Rubus odoratus	VI	252
Rubus palmatus	VI	146
Rubus parviflorus	VI	262
Rubus strigosus	VI	28
Rubus Suecicus	VI	142
Rubus ursinus	VI	42, 43, 58
Rubus villosus-canadensis	VI	262
Rue	III	72, 78
Ruffled Giant Petunia	X	126
Rumi Orange	IV	278
Rust	VIII	47-76
Rutabaga Seed	V	225, 229
Rutland, John M.	V	282
	VI	264
	VIII	260

	Vol.	Page.
Rutland Plumcot	V	292, 294
Rye	VIII	45, 46
SAGE	III	205
Salinas Burbank Potato	VII	286
Salmon Berry	VI	142
Salpiglosis	X	125
Salsify	VII	71
Salvia	X	64, 66
Salvia ramona	X	64
Salvia sonomensis	X	64
Sambucus Canadensis	VI	175
Sambucus glauca	VI	175, 179
Sambucus nigra	VI	175
Sambucus racemosa	VI	175
Sand Cherry	IV	100
Sandwich Island Mammoth Oyster Plant	VII	72
San Jose Scale	IV	50
Sans Noyau Plum	II	108, 110, 113, 118, 120
Santa Claus Melon	VII	45
Santa Rosa	XII	61-105
Santa Rosa Cactus	VIII	209, 242
Santa Rosa Plum	V	36, 74, 82, 223, 254
Santa Rosa Rose	IX	45
Santa Rosa Soft Shell Walnut	XI	37-41
Santa Rosa Strain of Shirley Poppy	IX	115
Sap-Hybridism	III	158
	VII	139
Sap Tapping	XI	242
Sassafras	XI	266
Satsuma Plum	V	14, 29, 32, 36, 38, 294
Scab	IV	50
Scented Calla	II	73-101
	IX	245-248
Scilla	VII	251
Scotch Fir	XI	257
Scuppernong Grapes	VI	200
Sea Island Cotton	VIII	112, 116
Sea Pine	XI	257
Sebastopol	XII	107
Seckel Pear	III	235
	IV	116, 136
Seedlings and Their Care	III	99-143
Seed Preservation	II	128
Seeds	III	116
	IV	194
	IX	242, 283
Selection, Principle of	XII	207-212, 246
Self-Fertilized Plants	III	72-78
Senses of Insects	III	207
Sensitive Plant	I	43-46
Sequoia	XI	173, 271-280
Sequoia sempervirens	XI	277
Sequoia gigantia	XI	277
Seralian, M. K	VI	195
Shaffer's Colossal Raspberry	VI	47, 48, 50, 68
Shaffer Raspberry	VI	42
Shagbark Hickory	XI	131-140, 156-161
Shasta Daisy	II	7-38, 59, 97
Shasta Daisy	III	228-238
	IX	135-152
Shellbark Hickory	XI	131-140, 157-161
Shell Flower	X	80
Shepherdia argentea	VI	248
Shepherdia canadensis	VI	248
Sheppard, Mrs	X	126
Sherwood Poppy (Miss)	X	153, 165
Shirley Poppy	IX	107-133
Shiro Plum	V	222
Shooting Star	X	62, 64
Shrubs	X	277
Siberian Raspberry	VI	52, 54
Side-Grafting	III	170
Silver Lining Poppy	IX	123
Simon, Eugene	V	223
Single-Husked Corn	VIII	13
Skinner System	X	253
Slugs	III	120, 141
Smith Cactus	VIII	187
Smith, Emery E	VIII	187
Smith Pear	IV	118
Snow Drift Clematis	X	222
Snake Cucumber	VII	44
Snap-Dragon Flower	III	214
Snowball	I	111
Snyder Blackberry	VI	25
Soft-Shell Walnuts	XI	36
Soil	X	280-291
Soil for Raising Seedlings	III	124
Solanaceae	VI	110
Solanums	VI	110-133
	VII	174, 223
Solanum Commersoni	II	281
	VII	302
Solanum guinense	VI	112, 116, 118, 119
Solanum Jamesii	II	280
Solanum maglia	II	283
	VII	297
Solanum nigrum	VI	115, 116, 118
Solanum villosum	VI	114, 116, 119, 122
Sonoches	VII	202
Sonoma Cactus	VIII	209
Sorghum	VIII	145-154
Souhegan Raspberry	VI	50
Sow Thistle	VII	202
Spanish Broom	III	217
Spartium junceum	III	217
Specific Needs	IV	7-35
Spencer, Herbert	II	32
Spineless Cactus	I	7-26
	VIII	169-208
Splendor Plum	II	249
Splendor Prune	V	112, 136
"Sports"	II	88-94, 120
	IV	146, 152
	VIII	17, 86
Spraying	IV	50
Sprekelia	IX	81, 94, 95
Spruce	XI	288-292
Spruce Gum	XI	260
Squash	VII	52-60
Squaw Potato	II	280
Squills	VII	249
Squirting Cucumber	I	97
Stamens	III	85, 88

INDEX TO VOLUMES I TO XII

	Vol.	Page.
Standards of Civilization	XII	212-216
Standard Prune	V	116, 121-128, 136
Stanley	VI	139
Starch	II	256
	VIII	32-40
Starflower	X	136
Stark Bros.	V	112
Stigma	III	87
Stock	III	150
Stone	V	145
Stoneless Peach	IV	168
Stoneless Plums	V	139-165
Stoneless Prunes	II	112
	V	132-165
Stowell's Evergreen Corn	VIII	40
Strawberry	II	290-295
	VI	73-104, 271
Strawberry Tomato	VII	225
Strawberry Tree	VI	264-266
Stubble Berry	VI	115
Suckering	VIII	22, 24
Sugar	II	255
	V	86, 88, 92, 93
	VIII	32 - 40, 142, 145-154, 163-167
	XI	239-246
Sugar-Beet	VIII	142, 163-167
Sugar Bush	XI	239-246
Sugar-Cane	VIII	133-154
Sugar Grape	VI	200
Sugar Maple	XI	240
Sugar Prune	II	235-269
	V	115-121, 136
Sugar Raspberry	VI	50
Sugar Trees	XI	239-269
Sultan Plum	V	36
Sultana Grape	VI	196
Sultanina Grape	VI	196
Sunberry	II	97
	III	10
	VI	105-133
Sunflower	VII	179
Swaar Apple	IV	192
Sweet Botan Plum	V	70
Sweet Clover	VIII	80
Sweet Pea	I	40-43, 97
	IX	27
Sweetwater Grape	VI	195, 206
Sweet Vernal Grass	VIII	289
"Symbiosis"	III	197
Syrian Grapes	VI	195, 196, 198
TANBARK	XI	124
Tapuna Cactus	VIII	190, 192
Taraxacifolia	X	70
Tarrytown Canna	IX	235-238
Tarweeds	III	31, 32, 39
	XI	249
Tecoma	X	227
Teosinte	I	126-130
	VIII	10-14
Texas Prolific Almond	XI	90
Textile Plants	VIII	107-132
Theoprastus	X	123
Thimble Berry	VI	258
Thistle	VII	198, 202
Thompson's Seedless Grapes	VI	195
Thompson, Sir J. J.	V	240
Thornless Blackberry	VI	7-38
Thrip	III	120, 141
Thyme	VII	164
Tiger Flowers	X	77-105
Tigridias	X	77-105
Tigridia buccifera	X	80
Tigridia pavonia	X	80
Timber Trees	XI	155-192
Timothy	VIII	77, 78
Tobacco	II	275-280
Tokay Grape	VI	195
Tomato	I	226-235
	VII	109-144
Tongue Graft	III	176
Top Grafting	III	176
Tradegy Prune	V	122, 268
Trailing Myrtle	X	237
Transplanting	III	134-138
Trees	X	275, 277
	XI	7-304
Tri-Colored Carnation	X	119-123
Trillium	I	31
	IX	267
Trillium ovatum	IX	267
Triumph Plumcot	V	299
Tropaeolum	X	185
Tropaeolum minus	X	186
Tropaeolum puberosum	X	185
Tschermak	VIII	56
Tulip Tree	XI	178, 294-295
Tunas	VIII	178, 190
Tunicate Corn	VIII	16, 17
Turkestan Alfalfa	VIII	90
Turner, Dr. Charles A.	III	212
Turnip	VII	66
Turpentine	XI	255-258
Typical Flower	III	85
ULTRA - VIOLET rays	II	50-52
"Unit Characters"	II	54-72, 123
	III	25, 26
	IV	74
	V	232, 234
	VII	88, 117
	VIII	57, 87
	XI	227-231
VACCINIUM	VI	166
Vallesneria spiralis	III	205
Value to Science and Agriculture	XII	155
Van Deman, Prof. H. E.	IV	214
	V	26
Van Deman Quince	IV	214, 216, 218
Van Mons, Jean Baptiste	IV	114, 122
Vant Hoff	IV	284, 287
Variety	IV	186
Vaughan, J. C.	IX	211, 224
	X	222
Vegetable Kingdom Classifications	I	217-229
Veitch	X	232
Venus Fly Trap	I	50
Verbena	X	107-119

	Vol.	Page.
Verbena erimoides...	X	117
Vicar of Winkfield Pear	IV	118
Villarsia nymphoides.	III	205
Vilmorin Brothers....	VIII	163
Vinca minor.....	X	237
Vines	X	215-233
Violet	I	113-116
	III	77
Virginia Creeper.....	X	215
Vitis antarctica.....	VI	198
Vitis Californica.....	VI	194
Vitis candicans.....	VI	200
Vitis Coignetiae.....	VI	198
Vitis cordifolia.....	VI	202
Vitis Foexeana.....	VI	200
Vitis hypoglossa.....	VI	200
Vitis monticola.....	VI	200
Vitis rupestris.....	VI	200
Vitis Texana.....	VI	200
Vitis vinifera.....	VI	190, 194, 195
Vitis vulpina.....	VI	202
Von Gaertner, Carl Friedrich	II	44
	XII	174
Vries, de, Prof. Hugo	II	55, 88, 90. 91, 94-98
	IV	284
	V	139
	VIII	56
	IX	90
	X	68, 70
	XI	198
	XII	151, 153, 194, 200, 247, 288

WAGHUSETTS Thornless Blackberry	VI	10
Wagener Apple.....	IV	192-194
Wallace	XII	23
Walnut	II	137-168, 298
	XI	8, 19-24, 35-61, 162, 193-238
Washington Navel Orange	V	162
Water	VII	10-22
Watsonia	IX	269-304
Watsonia Ardernei...	IX	273
Watsonia coccinea....	IX	278
Watsonia O'Brieni....	IX	273
Waverley Clematis...	X	222
Wax Berry.....	XI	266
Webber, H. H.....	VIII	121
Weeds	X	256-271
Weissman	XII	201
Western Sand Cherry	V	203, 212
Westralia Shasta Daisy	II	36
West's Mammoth Quince	IV	212
Wheat	I	88, 89
	III	26, 72, 74, 223, 224
	VIII	45-60, 68-76
Whip Graft.....	III	176
White Blackberry....	II	39-72, 97
	III	24
Whitelaria	IX	158
White Animals.....	II	49, 50
White Fruit Cactus..	VIII	189
White Sapote.....	IV	302
Wichuriana Rose.....	IX	63
Wickson, Prof. E. J..	V	71
Wickson Plum.....	V	71, 74, 82, 248, 251, 252, 254
Wild Artichoke.....	VII	187
Wild Black Raspberry	VI	42
Wild Geranium.....	IX	7
Wild-Goose Plum.....	V	203, 204
Wild Lettuce.....	I	48
Wild Oat.....	V	141
	VIII	299
Wild Teazel.....	VIII	301
Wilder Medal.....	IV	214
Wilks, Rev. W.....	IX	107
William's Favorite Apple	IV	192
Willits Orange.....	IV	276
Wilson Junior Blackberry	VI	27
Wine-Berry	VI	262, 264
Winter Rhubarb.....	II	169-199
	VII	209-222
Wistaria	X	229
Wistaria multiguga...	X	230
Wonderberry	VI	105-133
Wonder Ixia.....	X	150
Woodward, Dr.....	II	52
Wooly Aphis.....	IV	198
Wormwood	I	26
Wright, Alfred.....	XI	40
Wright, Sir Almroth	IV	132

YELLOW Bellflower Apple	IV	192
Yellow Calla.....	IX	253
Yerba buena.....	VII	161, 163
Yucca	III	197

ZANTA currants....	VI	196
Zea tunicata.....	VIII	13
Zea mais variegata	VIII	20
Zizania aquatica.....	VIII	277
Zygote	II	67

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